THURSDAY, JANUARY 29, 1920.

THE WORKS OF TORRICELLI.

Opere di Evangelista Torricelli. Edite da Gino Loria e Giuseppe Vassura. Vol. i. Parte 1. Pp. xxxviii + 407. Vol. i. Parte 2. Pp. 482. Vol. ii. Pp. 320. Vol. iii. Pp. 521. (Faenza: G. Montanari, 1919.) Price 60 franchi the 3 vols.

THIS work consists nominally of three volumes, of which the first contains mathematical papers, the second papers on mechanics, and the third the correspondence of Torricelli. In reality there are four volumes. It is to be hoped that this inconvenient way of describing the volumes of a work will soon go out of fashion. This is the first complete edition of the collected writings of Evangelista Torricelli; it is published under the auspices of the municipality of his native town, Faenza, who have in this way raised a lasting memorial to their celebrated townsman.

Torricelli was born in 1608, and died in 1647. In the introduction to vol. i., Signor Loria has given the few particulars about his life which it has been possible to gather. In 1627 Torricelli went to Rome to study under Benedetto Castelli, a disciple of Galileo, who in the previous year had been appointed professor of mathematics there. He seems to have remained at Rome until October, 1641, when Galileo, who had heard from Castelli of the valuable work in dynamics done by his pupil, invited him to Arcetri. Torricelli gladly accepted the invitation, but was only for a few months able to benefit by the instruction thus offered, as Galileo died on January 6, 1642. Soon after, Torricelli was appointed to the post of mathematician to the Grand Duke of Tuscany held by Galileo, and spent the few remaining years of his life at Florence until his death on October 25, 1647. The subsequent fate of his unpublished papers and letters is told in the introduction; they had a narrow escape from total destruction in 1733, when they were sold as waste paper to a pork butcher. Fortunately, the first customer to whom one of the papers was handed, wrapped round a sausage, was Nelli, the biographer of Galileo, who to his horror recognised the handwriting of the great man, and at once secured the whole pile of papers.

It was the study of Galileo's "Discorsi e dimonstrazioni matematiche intorno a due nuove scienze" which led Torricelli to make further investigations in dynamics and hydrodynamics. His principal results appeared in two books, "De motu gravium naturaliter descendentium" and "De motu projectorum," which appeared in a volume of tracts, "Opera geometrica," published in 1644. It is the second of these which contains his experiments on the flow of fluids from vessels through a small orifice. These experiments had been commenced by Castelli, whose erroneous result, that the velocity of outflow was proportional to the depth from the surface, was corrected by Torricelli. He showed that the quantity of water flowing from a hole in the horizontal bottom of a vessel in equal times was proportional to the series of odd numbers, if the quantity flowing out in the last unit of time was put equal to one. A particle from the surface flows out with a velocity equal to that which it would have acquired by falling from its original height over the opening. Therefore the outflowing velocity is proportional to the square root of the height. From this it followed that the figure of a jet issuing from a small hole in the side of a vessel is a parabola. Among Torricelli's discoveries is also the mechanical principle that if two or more bodies are so connected that their motion will neither make their centre of gravity rise nor fall: they are in equilibrium.

The fame of Torricelli rests, however, mainly on his discovery of air-pressure. He knew from Galileo that water would not rise in a tube closed at the top more than 33 ft., which was supposed to indicate that Nature's dislike to empty space (*horror vacui*) had a limit. Torricelli thought that this was nonsense and that it would be interesting to experiment with a heavier fluid. He anticipated that mercury would rise only to one-thirteenth of the height to which water would rise. At his instigation Viviani made the experiment in 1643, and found that the column of mercury in a tube closed at one end and inverted in a vessel containing mercury sank to about 30 in. and remained there. Torricelli found, however, by repeated measures that the height of the column of mercury was always changing, and he rightly interpreted this as indicating changes in the pressure exercised by the air on the open surface of the mercury. In a letter to his friend Ricci of June 11, 1644 (vol. iii., p. 186), he says that he has made these experiments, not to produce a vacuum, but chiefly to make an instrument for measuring changes in the density of the air. He explains that we live at the bottom of an ocean of air, the weight of which at the surface of the earth is about equal to one-four-hundredth of the weight of an equal volume of water. During the remaining three years of his life Torricelli does not seem to have pursued these researches further, and the new doctrine was not universally accepted until Pascal in 1648 had proved the connection of barometric height with the height of the observer above the

surface of the earth, and Guericke soon after had proved by experiments the enormous power of the pressure of the air.

Not a few of the mathematical papers published in the first (double) volume have never been printed before. They deal with conic sections, spirals (Torricelli discovered the logarithmic spiral), maxima and minima, etc. They make us feel that if a longer span of life had been granted him he would have taken his place among those mathematicians who paved the way for the advent of the differential calculus. The quadrature of the cycloid was one of the subjects treated in the "Opera geometrica." It is well known that Roberval charged Torricelli with having stolen his results on this subject, as well as Fermat's method of maxima and minima, and that Pascal was weak enough to publish this accusation in 1658, adding the assertion that Torricelli had confessed the robbery. This outrageous charge was soon after proved by Carlo Dati and Wallis to be utterly groundless, and it only showed that Roberval was not very particular as to the truth of any statement he made. There is no reason whatever to doubt that Torricelli found his results independently.

This new edition is in every way satisfactory, but we could have wished that the pages of the originals had been given in the margin. This is too often neglected by editors of a man's collected works, and the omission makes it very difficult to look up quotations from the original editions.

J. L. E. D.

PROBLEMS OF THE FRUIT-GROWER.

Science and Fruit-Growing: Being an Account of the Results obtained at the Woburn Experimental Fruit Farm since its Foundation in 1894. By the Duke of Bedford and Spencer Pickering. Pp. xxii+351. (London: Macmillan and Co., Ltd., 1919.) Price 12*s.* 6*d.* net.

THE appearance of this volume will be welcomed by all interested in scientific pomology, and the practical fruit-grower should find it indispensable as a work of reference dealing with many of the problems with which in some form or other he is constantly faced. In neither case will the contents be unfamiliar, since the investigations at Woburn have been closely followed throughout their course, and the results have been published at intervals in a series of reports. Some of the latter, however, have been long out of print, and for this and other obvious reasons the publication of a connected and comprehensive account of the many-sided work conducted at Woburn since its foundation will be appreciated.

The preface quotes at length an article which appeared in NATURE of September 19, 1895, dealing with the genesis of the station, which was due entirely to the public-spirited enterprise of the Duke of Bedford, who furnished the necessary financial aid, and of Mr. Spencer Pickering, who has now for a quarter of a century devoted himself to the elucidation of some of the problems of the fruit-grower, and has laboured single-handed and under the additional handicap, in recent years, of ill-health. Under these conditions the volume of achievement has been remarkable; and although the authors recognise the limitation of aim necessitated by force of circumstances and plead for leniency of criticism, they may be assured that, notwithstanding the controversial character of much of their work and the storms of adverse opinion aroused from time to time, the world of horticulture recognises the great debt which it owes to them both for the value of their researches and for the stimulus given to scientific investigation in horticulture in this country.

It is impossible within the limits of a short review to include adequate notice of all the subjects of horticultural importance considered in this volume. Their range is extremely wide, successive chapters dealing with investigations on soil preparation for planting, methods of planting, pruning, manures, spring frost damage and its prevention, the fruiting of trees in successive seasons, the flowering of apple trees, insecticides and fungicides, insect and fungoid pests, soil sterilisation, the effect of grass on trees, the toxic action of one crop on another, the behaviour of plants in masses, and flocculation in soils. Since, however, opportunity for individual treatment has already been provided on the occasions of the appearance of the separate reports previously referred to, attention here may be confined to a few of the more general issues.

Except in the direction of chemistry, the goal aimed at was the investigation of those cultural problems in which much work could be done without the assistance of specialists in the respective branches of science concerned, since the station was not equipped for a more varied programme. The field of work which it was possible to cover within those limits was, however, remarkably wide, as the list of subjects just enumerated indicates. How far towards the solution of such cultural problems progress can be made under these conditions depends obviously on the nature of the individual problem; but, without in any way detracting from the value of the Woburn work, its main result has been to emphasise the need for

the co-operation of the plant physiologist, the soil chemist and physicist, the entomologist, and the mycologist with the expert pomologist in investigations of this character. The ideal fruit experiment station, as the authors recognise in their preface, must be equipped to meet that need.

The difficulties experienced in the measurement of results of experiments on fruit culture have been adequately recognised. The Woburn methods of measurement appear, on the whole, satisfactory, although in certain cases to average the combined results of varieties of dissimilar character tends to obscure their significance. Experience at Woburn has apparently but rarely demonstrated that selection of results by the investigator is necessary, but in this respect the authors have perhaps been particularly fortunate in escaping anomalous behaviour on the part of individual trees caused by pest damage, local soil variations, or other accidental circumstances. It is interesting to note that their conclusions as to the minimum number of trees or plants which each plot under treatment should contain accord closely with those based on recent work in the United States.

The extent to which the results in the experiments with fruit trees may have been affected by root-stock variations cannot be estimated, since the nature of the root-stock and the precautions taken to ensure uniformity are not generally specifically stated. Recent investigations at East Malling and Long Ashton have demonstrated such wide variations in the characters of both Paradise and free stocks in the case of the apple, for example, that it is clear that uniformity of root-stock must be secured if the results are to be beyond criticism.

The investigations on insecticides and fungicides are of particular interest to plant pathologists, since, even if few or none of Pickering's formulæ for individual spray fluids establish themselves in general use, much light has been thrown upon the chemical side of the subject, especially in the case of Bordeaux and Burgundy mixtures. The view adopted as to the method of fungicidal action of the copper compounds concerned in the latter spray fluids has been the subject of considerable controversy, and there are, probably, too many weak points in the evidence adduced and in the line of argument taken in the discussion to permit of its general acceptance.

In a work of this description, covering so wide a range of subjects, it is not surprising to find a few mis-statements, such, for example, as that the scale insect, *Aspidiotus ostreaeformis*, occurs only under glass in this country. Again, the assertion that the greater part of the naphthalene in naphthalene-paraffin-soft soap insecticides of the paranaph type separates out on dilution does not hold in cases where the naphthalene is first dissolved in the paraffin. They are, however, but minor defects in a work distinguished for interest and originality, and sure to serve as a fruitful source of inspiration in many directions.

METAPHYSICAL RESEARCH.

Proceedings of the Aristotelian Society. New series. Vol. xix. Containing the papers read before the Society during the fortieth session, 1918–19. Pp. iii+311. (London: Williams and Norgate, 1919.) Price 20*s.* net.

Problems of Science and Philosophy. Aristotelian Society. Supplementary Volume ii. The Papers read at the Joint Session of the Aristotelian Society, the British Psychological Society, and the Mind Association, held at Bedford College, London, July 11–14, 1919. Pp. iii+220. (London: Williams and Norgate, 1919.) Price 12*s.* 6*d.* net.

THE old idea of metaphysics, that it marks a stage of human intellectual activity when, dissatisfied with a primitive anthropomorphic projection of images which peopled the unseen world with gods and developed a theology, man formed for himself abstract entities and quiddities and put these in the place of his gods—a stage of intellectual activity from which we have now passed to the clear, sane world of positive science—has long passed away. The well-worn joke of the metaphysician looking for a black hat in a dark room no longer raises a smile. Metaphysical research is coming into ever closer relations with scientific problems. It is now seen to penetrate deeply into every problem of physics and biology, as well as of psychology. The annual volume of the "Proceedings of the Aristotelian Society" and the supplementary volume entitled "Problems of Science and Philosophy" clearly indicate this new orientation.

The supplementary volume is of special interest from the point of view of science. The Aristotelian Society has organised for some years past an extra session, in which representative leaders in the sciences are invited to join professed philosophers in discussing the fundamental problems of science. The session was held this summer at Bedford College, London, and attracted very wide interest. This volume contains the published papers which were issued for the discussions. They reach a high standard, and are likely to

influence the direction of scientific speculation for some time to come.

In the first paper Mr. Bertrand Russell has given a very lucid example of what he has described as scientific method in philosophy. He submits "pure experience" to exhaustive scientific analysis. The outcome, if we follow and accept the writer's argument, is surprising, and probably to most people disconcerting. Like Hume, he fails to discover anything in experience corresponding to the subject, or anything like an act of perceiving which might constitute a subject, and he concludes, therefore, that the subject of experience is a logical construction. The next article is of more distinctively scientific interest. It is a symposium on the subject of "Time, Space, and Material." It is discussed from several points of view, scientific and philosophical, by Prof. Whitehead, Sir Oliver Lodge, Prof. J. W. Nicholson, Dr. Henry Head, Mrs. Adrian Stephen, and Prof. Wildon Carr. The keynote is Prof. Whitehead's criticism of the concept of "all Nature at an instant" and his insistence that the ultimate datum of science is an event. The continuity which science must hypostatise is not an ether of space, but an ether of events. There are two other symposia of present interest, one on the problem of individuality with particular reference to the concept of the relation of the individual to God, the other on the epistemological problem: "Is there 'knowledge by acquaintance'?"

The annual volume contains ten papers read during the past session of varied, but without exception of high, interest. The presidential address by Dr. G. E. Moore on "Some Judgments of Perception" is an admirable piece of close reasoning in analysis of a simple judgment, such as "That is an inkstand." Methodological problems of various kinds are discussed in papers by Prof. Laird, Mr. C. D. Broad, Mr. A. E. Heath, and Prof. J. B. Baillie. Prof. Wildon Carr expounds and defends the concept of "windowless" monads. Mrs. Duddington, in a paper on "Our Knowledge of Other Minds," develops an interesting theory of the immediacy and directness of this knowledge. Principal Jevons writes an appreciation of Tagore. Mr. A. F. Shand has an original study of deep psychological interest on "Emotion and Value." The last paper in the volume is by the Dean of St. Paul's on "Platonism and Immortality." It is a philosophical treatment of the most profound problem in social and political ethics, one which, moreover, is of great scientific interest—is there any reason to believe in human progress? The Dean holds that there is not.

MEDICAL AND SOCIAL WAR-WORK IN EGYPT.

(1) *The Australian Army Medical Corps in Egypt. An Illustrated and Detailed Account of the Early Organisation and Work of the Australian Medical Units in Egypt in* 1914–1915. By Lt.-Col. J. W. Barrett and Lt. P. E. Deane. Pp. xiv+259. (London: H. K. Lewis and Co., Ltd., 1918.) Price 12*s.* 6*d.* net.

(2) *The War Work of the Y.M.C.A. in Egypt.* By Sir J. W. Barrett. Pp. xx+212. (London: H. K. Lewis and Co., Ltd., 1919.) Price 10*s.* 6*d.* net.

(1) THE first book gives a detailed account of the early organisation and work of the Australian Army Medical Corps in Egypt. Prior to the outbreak of war the Corps was of meagre dimensions, in spite of the fact that compulsory medical training had come into operation in Australia in 1911. When war was declared, the Australian Government decided to raise and equip a division, 18,000 strong, the medical establishment of which consisted of regimental medical officers and three field ambulances. Later, further divisions were raised and sent to the front. It soon became clear that "lines of communication medical units" were required, and the first hospital units with a 520-bed hospital arrived in Egypt in January, 1915, and were housed at the Heliopolis Palace Hotel. This afterwards expanded into hospital and convalescent accommodation consisting of 10,600 beds, and in the three days April 30–May 2, 1915, no fewer than 1352 cases were admitted from Gallipoli, and were successfully dealt with—a sufficient tribute to the completeness of the organisation. A general review is given of the sickness and mortality among the Australians, and of the steps taken to prevent epidemics. A chapter is devoted to venereal diseases—described as being the greatest problem of camp life in Egypt—in which much sound advice is given for dealing with these scourges. A further chapter deals with the work of the Red Cross in Egypt, and in another suggestions are made with the view of increasing the efficiency of the Australian Army Medical Service. Sir James Barrett and Lt. Deane have compiled a very readable and useful narrative, and the volume is illustrated with many plates.

(2) This volume deals not with the general work of the Young Men's Christian Association, but with the special war work so successfully undertaken by it in Egypt and Palestine. A brief account is first given of the foundation and general policy of the association and of its pre-war work in Egypt. Two months after war broke

out 20,000 Territorials reached Egypt, and the Y.M.C.A. at once began its work among them. At Heliopolis 5000 troops encamped in the desert, with nothing to do after the day's routine ended, and within four days a marquee had been obtained, and writing accommodation, followed by a circulating library and canteen, provided. In addition, postal facilities were arranged for three weeks until the Government post office was established, and some 1500–2000 letters were dealt with daily. From 1915 onwards soldiers' clubs were established in all the principal military centres of the Near East. Sir James Barrett bears eloquent testimony to the invaluable work of the Y.M.C.A. In a concluding sentence he says: "The strength, in my judgment, of this organisation lies in the fact that its members possess an ideal which finds expression in services to their fellows of the most practical character. . . . Whether we shall all agree with their ideals in the abstract or not is outside the question, for all can join in admiring and respecting their single-minded efforts to better humanity." Gen. Allenby, who contributes a preface, writes in a similar strain: "No one has more reason than I to be grateful to the Y.M.C.A. for its work in connection with the army. Throughout the campaign its workers have followed closely the fighting line, and their labours have done much to keep up the moral, mental, and physical efficiency of my troops. . . . Broad-minded Christianity, self-regardless devotion to work, a spirit of daring enterprise, and sound business guidance have built up an organisation which has earned the gratitude of the Empire."

SCIENTIFIC BIOGRAPHY.

(1) *Herschel.* By the Rev. Hector Macpherson. (Pioneers of Progress: Men of Science. Edited by Dr. S. Chapman.) Pp. 78. (London: S.P.C.K.; New York: The Macmillan Co., 1919.) Price 2*s.* net.

(2) *Lectures on Ten British Physicists of the Nineteenth Century.* By Alexander Macfarlane. (Mathematical Monographs: No. 20.) Pp. 144. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1919.) Price 7*s.* 6*d.* net.

(3) *Joseph Dalton Hooker.* By Prof. F. O. Bower. (Pioneers of Progress: Men of Science. Edited by Dr. S. Chapman.) Pp. 62. (London: S.P.C.K.; New York: The Macmillan Co., 1919.) Price 2*s.* net.

IN most directions we have had to abandon our aspirations and sanguine prophecies of a reconstruction which should lead to a better world and almost justify the horrors of war. But in one direction hope remains; there has certainly been a growth in the popular appreciation of science. However, like most good things, it has its dangers; it was the applications of science, rather than science itself, which stimulated popular interest during the war. We are not yet sure that the better judgment of value is based on a better understanding; and, if it is not, if science is to be appreciated merely because it is useful in the arts of war and peace, we shall soon be wishing fervently that interest may once more be replaced by apathy.

The danger is partly our own fault. We complain that the populace have neglected science; but science has also neglected the populace; we have not offered the laity of our best. "Popular science" has too often consisted of superficial lectures with showy experiments or trashy sentimentalism about the romance of radium and the starry heavens. We ought not to be surprised if those to whom science is presented in so unscientific a guise are indifferent to its value and ignorant of its meaning.

In order to make the laity understand rightly, we must start from a common ground. And there is a common ground: the proper study of mankind is man. Great men of science are often great men as well; by utilising the universal interest in great personalities, we may lead the way to a true comprehension of their work. Science, it is true, has a strong impersonal element; but it has also a strong personal element; it is on the latter that we must found a comprehension of the former. It is significant that an abstruse scientific problem has been noticed recently in the daily Press under such headlines as "Newton *v.* Einstein." The personal element of the matter was the first to appeal to the popular imagination.

For these reasons the volumes before us would have been welcome, even if they had represented an attempt rather than an achievement. It would not have been surprising if first attempts at popular scientific biographies had been partial failures; but here they are not. We have left little space to speak in detail of Mr. Macpherson's and Mr. Macfarlane's books, because all that there is to be said of them can be adequately conveyed in a single sentence. They are as good as they can be, and a great deal better than we should have imagined possible. Mr. Macpherson's task was perhaps as easy as that of a scientific biographer can be, for Sir William Herschel's work is easy to understand and the facts of his life might have been taken from a romantic novel; but everything looks easy when done by a master of the craft. Mr. Macfarlane's book is even more remarkable;

he gives about fourteen pages (it was originally an hour's lecture) to each of his subjects, and in that short compass manages to bring before his audience the picture of a complete personality, clearly distinguished from all the rest, and an adequate idea of the nature of his scientific work. There are a few minor inaccuracies, but our only quarrel is with the title, for of the ten (Maxwell, Tait, Rankine, Kelvin, Stokes, Airy, Adams, Whewell, Babbage, John Herschel) not all can strictly be said to be physicists. However, this is the fault of the editors, not of the author, for the book is posthumous; and we would not willingly part with any of the ten; Babbage, the least physical, is perhaps the most interesting. We are glad that neither of the authors is ashamed to tell again the old stories; the younger generation must learn them somewhere, and they could not be better told. But did Freddy Tait really drive that golf ball?

Concerning Prof. Bower's "Hooker," little also need be said. It is scholarly, as we should expect from its author, but, alas! it is not interesting. Prof. Bower has not, we think, managed to convey to his readers why either Hooker or his work was great. But some failures in an enterprise of this kind there must be; let us be thankful for the successes. Everyone ought to read Mr. Macpherson's and Mr. Macfarlane's books, and make all his acquaintances do the same. N. R. C.

OUR BOOKSHELF.

The Aviation Pocket-book for 1919–20. *A Compendium of Modern Practice and a Collection of Useful Notes, Formulae, Rules, Tables, and Data Relating to Aeronautics.* By R. Borlase Matthews. Seventh edition, revised and enlarged. Pp. xxiv+536. (London: Crosby Lockwood and Son, n.d.) Price 12*s.* 6*d.* net.

THE impression received from a perusal of this book is that the author's chief aim in life is the classification of data, and that the value of the data is of secondary importance. The elaborate arrangements which make the pocket-book suitable for cutting up to fit a number of standard loose-leaf books or card index cabinets are valuable in proportion to the value of the information contained on its leaves. Since many of the tables are inaccurate, it would appear that the author holds a different view.

The resistance of the wings of an aeroplane is stated to have an average value equal to 15 per cent. of the total for the aeroplane, whereas it is probably never less than 50 per cent., and certainly greater than 60 per cent. in the case of modern aeroplanes at economical flying speeds. In the case of engines, the variation of power with height is represented in a table which is seriously wrong when the height exceeds 10,000 ft. Even the tabulated characteristics of a standard atmosphere do not agree with those used in British aeronautics. The weight per horse-power of engines to be used in preliminary design is given too high; the maximum of 200 h.p. there quoted is insufficient to cover the needs of aviation in 1920.

One also wonders why some twenty pages are devoted to tables and formulæ referring to flat plates, whilst four suffice for what the author describes as "modern wings." These instances of defective data suggest that the author would have been better employed in correcting his data than in developing a classification system. It is fortunate that much of the data is taken solidly from the publications of such bodies as the British Engineering Standards Committee and the Royal Aeronautical Society, and it is as a very full index to these works that the pocket-book appears to find a justification for its existence.

A Manual of the Electro-Chemical Treatment of Seeds. By Dr. Charles Mercier. Pp. viii+134. (London: University of London Press, Ltd., 1919.) Price 3*s.* 6*d.* net.

THIS book is essentially a personal statement, and the reviewer is under the serious disadvantage that the distinguished author died soon after writing it, and can no longer make the rejoinder that a suitable critique would inevitably call forth. It deals entirely with a proprietary process for the treatment of seeds before sowing.

The process consists in placing the seeds in a 2½–5 per cent. solution of sodium or calcium chloride through which an electric current is passing, then taking them out and drying them. Five gallons of solution are needed per bushel of seed, and 8 watts of electricity per gallon. The drying is carried out by means of a blast of air heated to 100° F. The seed must then be sown as early as possible, as the effect lasts only a month.

Extraordinary increases in crop are claimed, and some astonishing photographs are reproduced in the book. Very few actual figures of crop weights, however, are available, and the author did not deal adequately with the awkward fact that the method had not been a success at the experimental stations where treated seed supplied by the proprietors had been tested. No useful purpose would, however, be served by referring further to such points as these, for Dr. Mercier cannot reply.

The New Hazell Annual and Almanack. By Dr. T. A. Ingram. Pp. 873. (London: Henry Frowde, Hodder and Stoughton, 1920.) Price 6*s.* net.

ON p. 206 of this useful annual we find a list of the Nobel prizemen for physics, chemistry, medicine, literature, and peace from 1901 onwards, together with a note on the Nobel foundation. This is an example of the kind of information which we expect to find in "Hazell," but not in other general annuals; and we are rarely disappointed. The sections on scientific and educational subjects are full of facts concisely presented, and the whole volume rightly claims a place upon every reference bookshelf.

LETTERS TO THE EDITOR.

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

The Deflection of Light during a Solar Eclipse.

IT may be worth while to give my endeavour to obtain a rough value for the refraction effect of the atmosphere during a total eclipse of the sun. The simplest case possible is when the sun is in the zenith.

I will assume that the air density of the normal atmosphere has been removed, and that there is left the atmosphere which produces the abnormal effects in question. This is not necessary, but it makes the calculation somewhat simpler.

If O be the place on the earth's surface of maximum air density, the density ρ_0 of the residual atmosphere there will be one-seventieth of the density of the normal atmosphere if we assume that it corresponds to a fall of 4° C. in the atmosphere when in equilibrium. Take Ox in the direction opposite to that of the motion of the shadow, and Oy the vertical passing through the centre of the moon's disc. This assumes that the density is greatest at the centre of the shadow, which is almost certainly incorrect. I will take the density at any point of the residual atmosphere in the plane of xy to be given by

$$\rho=\rho_0(1-\kappa x)e^{-\beta y},$$

where β, although it varies with temperature, is assumed to be constant and equal to $1{\cdot}3\times10^{-6}$, distances being measured in centimetres. If we assume that the density of the atmosphere becomes normal at 150 miles distance from O, κ will be $4{\cdot}17\times10^{-8}$.

With these values of the two constants, the above formula expresses that the horizontal density gradient is uniform and independent of height, and that the atmosphere has its normal density at a distance of 150 miles. None of these statements is correct. The shadow-cone in the earth's atmosphere acts like a down-draught chimney or a kind of thermal air-compression pump, increasing the density in the central region of the shadow and diminishing it in surrounding regions. Thus κ may have a very much greater value than that given above, and, indeed, the factor $1-\kappa x$ may be quite incorrect in form.

However, taking this formula for the density, the index of refraction of the residual atmosphere at any point is

$$\mu=1+(\mu_0-1)(1-\kappa x)e^{-\beta y},$$

where $\mu_0=1{\cdot}000004$.

The path of any ray in the plane of xy might be got by solving the usual differential equation for this case, but I have not succeeded in getting a solution. However, the amount of the deviation can be obtained without knowing the actual path.

If ϕ be the angle which the tangent to a curve of equal refractive index makes with the axis of x, we have

$$\tan\phi=\frac{\partial\mu}{\partial x}\Big/\frac{\partial\mu}{\partial y}=\frac{\kappa}{\beta(1-\kappa x)}.$$

It can easily be shown that the radius of curvature of the lines of equal density or refractive index in the neighbourhood of the axis of y is much greater than the radius of the earth. Thus, as we have assumed the earth's surface to be plane, we can assume these lines to be straight in the portion of the atmosphere concerned. On the axis of y, $\tan\phi=0{\cdot}032$, and for an observer at O the refraction of the light coming from a star near the edge of the sun's disc will be the same as if he were looking through an atmosphere stratified in parallel planes, making an angle ϕ with the horizon. A ray coming from such a star will make an angle of $\phi-15'$ with the normal to these planes, and the refraction will be

$$\begin{aligned}&(\mu_0-1)\tan(\phi-15')\\&=0{\cdot}000004\times0{\cdot}0277\\&=1108\times10^{-10}\text{ or }0{\cdot}023''.\end{aligned}$$

If the ray come from a star the angular distance of which from the sun's centre is 45′, the result is 0·0082″, which is a little more than one-third of 0·023″. But if, as I believe, κ has been greatly underestimated, the possible values of these refractions are much greater.

If the observer be not at the origin, but at a distance along the positive direction of the x-axis, the refraction of the light from stars on the other side of the sun's disc will not be away from the sun's centre, but towards it, and *vice-versa*, if he be on the other side of the origin. But no difficulty of this kind occurs for refraction in planes perpendicular to Ox if the position of the observer be on the x-axis. Perhaps it is worth mentioning that, from the only account of the observations I have seen, it appears that, with the exception of one star, all the changes in right ascension were of the same sign, whereas the changes in declination were all in the right direction.

I ought to mention in reference to Sir Arthur Schuster's letter (NATURE, January 8, p. 468) that I never thought of a ray that, in its passage through the earth's atmosphere, lay partly inside and partly outside the umbra. And I thank him for correcting the slip that I made in the angular radius of the sun's disc. In these days of relativity, an error of fifteen minutes either of arc or of time is, perhaps, excusable.

ALEXR. ANDERSON.

University College, Galway, January 14.

"The White Water."

IT is possible that some readers of NATURE can enlighten me on the cause and nature of what the Arabs call "The White Water." This phenomenon was witnessed by me on two occasions at the entrance to the Persian Gulf in the vicinity of the Quoin. On both occasions the time was about 8 p.m. There was no moon on the first occasion, but a moon on the second.

I first observed what appeared to be a line of breakers ahead of the ship; this was not possible because we were in deep water and the position of the ship was known. As we approached, it seemed that these supposed breakers were a succession of phosphorescent waves of a period of about sixty to the minute. The waves extended, so far as could be seen, for about two miles.

In addition to these waves there were also phosphorescent Catherine-wheels, both right- and left-handed, also phosphorescent light apparently coming to the surface and radiating out in all directions.

The phenomena lasted for about half an hour, gradually fading away, apparently sinking. There were strong atmospheric disturbances at the time. Both nights were clear and the sea was calm. I could obtain no local information. I may add, in conclusion, that I was not the only person who witnessed this display.

A. R. PALMER.

Portsmouth, January 13.

I HOPE that Capt. Palmer's letter will induce officers of the Indian Marine to investigate any cases of "White Water" that come under their notice. I am

sure that the director and staff of the Indian Museum at Calcutta, where the collections of the I.M.S. investigator are deposited, will give them every assistance, and examine any specimens they may obtain. We want to know what are the organisms concerned in the production of the phosphorescence, and the physical conditions of the water in which they were living. The organisms can be strained out of the water by a silken or muslin net—or the hose turned to run through a piece of either cloth—and preserved in spirit or formic aldehyde (1 part in 30 of sea-water). They should be accompanied by exact information as to position, state of weather and moon, and temperature of the water; a sample of the actual water in a green beer-bottle would also be useful.

Phosphorescence so diffused as to make the sea appear absolutely white is, in my experience, rare. Indeed, I have seen "White Water" only on two occasions; the first halfway between Ceylon and Minikoi, on a dirty night towards the end of May, 1899 (heavy weather from south-west, maximum effect about 9.30 p.m., dark again by 11 p.m.); the second seen from Minikoi, about five weeks later, at the commencement of the Great Monsoon (south-west), time 9–10 p.m. A bottled sample of the water of the first showed only the same organisms as normally produce "sparks," but a tow-net sample of the second was so rich in the eggs, etc., of the organisms, which inhabit the slopes of Minikoi, and in breeding worms that normally bore into its corals, that I regarded it as perhaps a seasonal breeding phenomenon.

Waves of fire produced by myriads of sparks from minute water-fleas (especially Ostracods) and Protozoa are common in such tropical seas, but they merely mark the wind waves, and are not the same as the waves described by Capt. Palmer, which I think must be due to an optical effect. Globe or lantern-like effects produced by umbrella or barrel-shaped jelly-fish I associate with calm weather. They are most noticeable in the early part of the night, and do not usually last for more than an hour or two. As patches up to a few hundred yards across occur, and as the jelly-fish are sometimes so abundant that they can be collected in a bucket thrown overboard, the sea might be described as "White Water," but I am sure that this is not what the fishermen of the Indian Ocean know by that name. Fish passing through water highly charged with phosphorescent organisms frequently execute Catherine-wheels, etc., but fish themselves are often phosphorescent from bacteria living upon their skin. J. STANLEY GARDINER.

Zoological Laboratory, The Museums, Cambridge.

Proposals for a Plumage Bill.

PROF. DUERDEN'S letter in NATURE of January 15 might by its phrasing lead to the supposition that a few persons only are agitating for a novel Bill to prohibit the importation of plumage. The trade has been keenly opposed by all naturalists, not only in Great Britain, but also in the United States, Canada, Australia, and nearly every country in Europe for many years. The arguments now used were all urged by the trade when the Government Bill of 1914 passed its second reading in the House of Commons.

We are told that the introduction of another Bill will be "viewed with alarm in South Africa," although the ostrich-feather trade is a British Colonial industry carried on under totally different conditions from those of the trade in wild birds' (or "fancy") plumage. In December, 1913, the hon. secretary of the Ostrich Farmers' Association of South Africa, representing 1700 farmers, wrote to the Royal Society for the Protection of Birds as follows:—"My association has from time to time taken the feeling of its members on the subject-matter of the Bill about to be introduced by Mr. Hobhouse, and they have expressed their entire sympathy with, and approval of, the Bill. . . . The attitude taken up by the feather dealers in London is inexplicable to my association, and you have my assurance that they have not the least support from a single ostrich farmer in South Africa."

With regard to the "serious slump" said to have resulted from the Anti-Plumage Bill of 1914, it may readily be supposed that all such luxuries as feathers would suffer a slump during the war; but, as a matter of fact, one of the chief London brokers reported in 1915 that, "in spite of many difficulties, a large quantity of goods has been dealt with," and that there had been "a sudden improved demand from America." This demand followed the passing of the tariff clause prohibiting the importation into the United States of all "fancy" feathers.

Prof. Duerden himself reasons that decrease in "fancy" feathers would improve trade in ostrich feathers when he argues that the æsthetic tastes we have inherited from our barbarian ancestors demand that we should decorate ourselves with feathers of some sort.

The argument that we must encourage a French industry is also well-worn. It is true that the traders in Paris cried out in 1914 that the Hobhouse Bill was designed to protect the ostrich feather industry of the Cape at the expense of Parisian feather-dressers; but the Société d'Acclimatation de France replied: "The interests of workpeople will not be affected. . . . It is only a very small batch of speculators that can have to suffer. They are very rich."

Prof. Duerden has "grave doubts" whether the "ruthless destruction of birds" for trade can best be prevented by discouraging or prohibiting that trade. It is open to him to suggest a better way. The proposition that birds-of-paradise, lyre-birds, egrets, herons, trogons, orioles, terns, kingfishers, and all the rest of the feather-traders' victims, from albatross to humming-bird, might be "farmed" after the manner of the flightless ostrich, and plucked or killed for the market "in conformity with the highest humane demands," may be of interest to aviculturists; it has no practical bearing on the question of to-day. What science and humanity alike demand is immediate action to save the birds of the world from the ruthless and stupendous slaughter on which the trade now lives. L. GARDINER,

Secretary, Royal Society for the Protection of Birds.

23 Queen Anne's Gate, S.W.1, January 20.

THE suggestion made by Prof. Duerden (NATURE, January 15) for special breeding of birds as an alternative to prohibiting imports of their plumage is unacceptable to us for several reasons, but of these I need now only mention one, since this one appears to us conclusive. We hold that it would be impossible for the Customs to differentiate between the feathers of those birds which had been "farmed" and of those which had fallen victims to the ruthless plume-hunter. Prof. Duerden is, perhaps, unaware that a scheme similar to that which he adumbrates was advanced in 1914 by the Committee for the Economic Preservation of Birds, and was considered by the Government of the day to be unworkable.

The idea of our desired Bill being dangerous to the ostrich-farming industry has surprised us, previous Plumage Bills having been warmly supported by the

leading farmers of South Africa. May not the glut in ostrich feathers to which Prof. Duerden refers have been caused by "fashion" showing a sudden preference for those other plumes of which the sale might soon have been prohibited by law?

Naturally, the French *plumasserie* is hostile to us. That, we think, is more than counterbalanced by the sympathy of distinguished and disinterested Frenchmen like M. Harancourt, curator of the Musée de Cluny, and of various French and Italian societies for the preservation and protection of birds and animals.

WILLOUGHBY DEWAR,
Hon. Sec. Plumage Bill Group.
8 Kenilworth Court, Putney, S.W.15,
January 25.

The Separation of Isotopes.

IN view of recent work by Ashton, the practical aspect of this problem again becomes important. Considerable weight must be given to the conception of Lindemann and Ashton (*Phil. Mag.*, May, 1919) that isotopes are capable of chemical as well as of physical separation.

As it is extremely improbable that I shall be able to return to practical work in radio-chemistry in the near future, I wish to put on record what seems to be a further very exact method of testing the chemical separability of isotopes.

If an ester—for example, ethyl acetate—is heated with a base—for example, a solution of barium hydroxide—the ester will be saponified and the barium salt precipitated. The reaction is, of course, a fairly slow one, and the precipitated salt can be filtered off from time to time.

The fraction of ester saponified in any given time is proportional to the concentration of hydroxyl ion. If, therefore, in place of pure baryta a solution of barium hydroxide containing a small quantity of radium hydrate with one of its isotopes, say mesothorium-1, is used, we shall get a precipitate containing barium radium and mesothorium-1. The quantities of these two elements precipitated are capable of exact measurement, and will depend on the strength of their bases. The results obtained will thus be independent of any phenomenon such as solution, which is neither a clearly defined physical property nor yet solely a chemical one, but will be dependent on a purely chemical phenomenon, namely, the strength of the base and its consequent relative power to break up a molecule of the ester. If, therefore, the ratio of radium to mesothorium-1 in the first precipitated fraction is compared with the same ratio in a later fraction, a comparison will have been obtained of their reactive powers. ALEXANDER FLECK.

26 Manor House Road, Jesmond,
Newcastle-upon-Tyne.

A Helium Series in the Extreme Ultra-Violet.

I FEAR I cannot agree with the arrangement of spectral lines proposed by Dr. Hicks (NATURE, December 18, 1919). The evidence shows that the lines he has selected do not all belong to the same element. I tried to make this clear in my article which he quotes (*Astrophysical Journal*, vol. xliii., 1916, pp. 100–1).

My note of November 20 was intended to direct attention to the fact that while the lines 1216, 1026, and 972 are probably due to hydrogen, and form a series predicted by Ritz, the lines 1640 and 1215 are homologous, and are due to helium; 1086 and 992 I ascribe to an impurity.

It seems to me that the proposal of Dr. Hicks illustrates the danger of selecting spectral lines from a table without due regard to their physical characteristics. THEODORE LYMAN.

Harvard University, January 10.

Mirage Effects.

A NOTICE appeared in NATURE of January 1 (p. 458) of a communication to the Royal Society of Edinburgh by Mr. G. F. Quilter respecting mirage in the form of "pools of water" as seen in the street at Ingatestone.

It is highly probable that a similar phenomenon occurs here at Hastings. Sometimes on hot, sunny days, if one walks along the promenade, the ground some distance ahead appears to be dark and polished, as if wet; and vehicles and pedestrians (particularly if the latter have white dresses) are reflected in the surface. On close approach the appearance vanishes.

The phenomenon has been seen elsewhere in this locality, especially on the asphalt at the top of Wellington Road. In this case, when it has vanished, it may be revived by stooping. It seems as if elevation of the eye-level affects visibility.

It has been observed by Mr. W. Ruskin Butterfield, the borough meteorologist and curator of the museum at Hastings, as well as by the writer of this note. CICELY M. BOTLEY.

10 Wellington Road, Hastings, January 24.

British Iron-ores.

IN a review in NATURE for January 1 (p. 429) Prof. Louis appears to take exception to Sir Aubrey Strahan's division into "three classes, namely, those products, mostly hæmatites, which occur as replacements, in lodes, etc. . . ." It would be well to remember that true lodes or veins of iron-ore *do* occur in Cumberland, as at Knockmurton Mine (disused), where gash-veins of hæmatite occur in the Skiddaw Slate, and in Eskdale, where veins occur in granite, the most important being at Nab Gill Mine. It appears to me that the word "lodes" in the description has no connection with "replacements," but is used to cover such deposits as I have mentioned.

D. A. E. EVANS.

High House, St. Bees, Cumberland,
January 3.

IT is perfectly well known that true lodes of hæmatite occur in various places, those in the Skiddaw slates referred to by Mr. Evans being typical examples; and so far I am in entire agreement with him. My criticism takes no exception at all to Sir Aubrey Strahan's classification, but is directed only to the possibility that some readers of his preface might assume from it that he regards "lodes" and "replacements" as equivalent terms. HENRY LOUIS.

Displacement of Spectral Lines.

IN view of the discussion in NATURE and elsewhere on this subject, the following extract from a recent letter of Prof. Einstein may be of interest:

"Zwei junge Physiker in Bonn haben nun die Rot-Verschiebung der Spektral-Linien bei der Sonne so gut wie sicher nachgewiesen und die Gründe des bisherigen Misslingens aufgeklärt."

I have heard no details, but doubtless an account of this work will be available before long.

ROBERT W. LAWSON.

The Physics Laboratory, The University,
Sheffield, January 23.

ORTHOGENETIC EVOLUTION IN PIGEONS.[1]

THE three volumes before us, by one of the leading American naturalists of his time, form one of the most important landmarks in evolutionary study since Mendel, Bateson, and de Vries, or in some respects even since Darwin. For Whitman built broadly, and we believe in large measure securely, upon the foundations Darwin laid. His study involved the breeding of wild species of pigeons from all parts of the world, a work which was carried on for eighteen years until interrupted by his death in 1910. Some of the unfinished breeding experiments were continued five years longer by one of his editors, Dr. O. Riddle, who has prepared the work for the press. Parts of the results are incomplete, but it is doubtful if further work would have altered the author's conclusions and views in any important respect. These volumes make available the greater part of Whitman's unpublished researches on pigeons, together with various addresses on the general problems of heredity and evolution. Some of the latter had previously been published, but find here a useful setting in connection with the mass of facts on which they are based.

As Dr. Riddle aptly remarks, "the dominant feature of Prof. Whitman's prolonged study of inheritance and evolution lies in its intensive and diversified attack upon the nature of a specific character." Since Eimer's abortive efforts to prove orthogenesis in lizards and butterflies, on the basis of acquired characters, the subject has received little attention except from palæontologists. The present work may therefore be considered to represent the first important experimental contribution favouring orthogenesis as an evolutionary factor. As such, it is certain to arouse wide discussion in biological circles. A few of the salient points in this work may be considered.

(1) From a broad survey of the colour patterns in wild pigeons throughout the world, Whitman concluded that they represent different stages in reduction from an original chequered pattern to a series of bars on the wing—four, three, two, and finally one bar. This reduction proceeds from before backwards until ultimately all traces of the last bar are removed and the wing remains a *tabula rasa*, as in the white-winged pigeon, *Melopelia leucoptera* (Fig. 1). This series, worked out in surprising detail from the study of every individual feather, is found to be traceable independently in all the different families of pigeons, and therefore to represent an orthogenetic tendency in the whole group. The chequered pattern is believed to be primitive not only for pigeons, but also for the whole avian phylum.

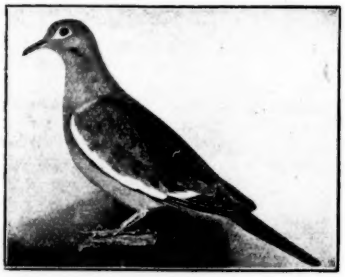


FIG. 1.—*Melopelia leucoptera*. The feathers at lower edge of wing are white, but there are no chequers in the adult.

The rock pigeon, *Columba livia* (Fig. 2, *a*), from which Darwin showed that all domestic varieties of pigeons are probably descended, has two black bars on its wings. But birds with chequered wings (Fig. 2, *b*) also occur,

FIG. 2.—(*a*) Two-barred rock pigeon, *Columba livia*, from the caves of Cromarty, Scotland, 1908. (*b*) Chequered wild rock pigeon, *C. affinis*, from the same locality.

and have been looked upon as a separate species. Darwin, from his study chiefly of domestic varieties, believed that the chequered type was more advanced than the two-barred, thus reading the series in the opposite

[1] "Orthogenetic Evolution in Pigeons." Posthumous Works of Prof. Charles Otis Whitman. Vol. i. Edited by Oscar Riddle. Publication No. 257. Pp. x+194+88 plates. (Washington: Carnegie Institution of Washington, 1919.)

"Inheritance, Fertility, and the Dominance of Sex and Color in Hybrids of Wild Species of Pigeons." Posthumous Works of Prof. Charles Otis Whitman. Vol. ii. Edited by Oscar Riddle. Publication No. 257. Pp. x+224+39 plates. (Washington: Carnegie Institution of Washington, 1919.)

"The Behavior of Pigeons." Posthumous Works of Prof. Charles Otis Whitman. Vol. iii. Edited by Prof. Harvey A. Carr. With a Preface by Oscar Riddle. Publication No. 257. Pp. xi+161. (Washington: Carnegie Institution of Washington, 1919.)

direction. Whitman's most cogent evidence is derived from a knowledge of the juvenal plumage in many wild species, and naturalists can scarcely fail to agree with his interpretation on this point, for he shows that many species which have more or less completely lost their chequers or bars in the adult plumage pass through a stage in which these markings appear.

(2) This brings out another aspect of Whitman's work—his strong support of the recapitulation theory. In his own words, "all development . . . is essentially a repeating or recapitulating process. This is the central fact of heredity and the doctrine of descent." Elsewhere he refers to heredity as "nature's silent rehearsal of past history." In this connection he pointed out that the formula, "ontogeny recapitulates phylogeny," places the emphasis in the wrong place, since phylogeny can be nothing more than the lineal sequences of ontogeny regarded from the historical point of view, while recapitulation is simply reproductive repetition. The orthogenetic process is considered to be the primary and fundamental one, which bridges the incipient stages of characters until natural selection can get a foothold, and may even sweep onwards and completely

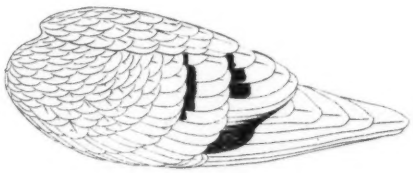


FIG. 3.—Wing of *Columba aenas*, related to *C. livia*. The two bars are incomplete.

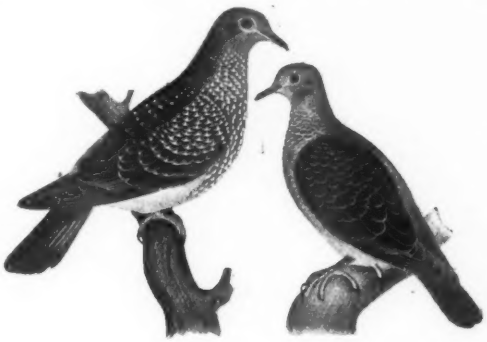
erase a pattern which selection would have retained.

That something other than selection is at work on these patterns is indicated also in such species as the European stock-dove, *Columba aenas* (Fig. 3). In this species the reduction of the bars has proceeded farther than in the rock pigeon, but the spots composing some of the partial bars are completely concealed by overlying feathers.

The same process is studied in great detail in the crested pigeons of Australia, the phylogeny being interpreted as "always advancing in one predetermined direction, like a tidal flow guided along a prepared channel, and flowing to varying distances, according to the initial momentum."

(3) Perfect continuity in development and variation is another feature which Whitman is at great pains to demonstrate. By plucking feathers at intervals from the juvenal plumage, he showed that underlying the apparent discontinuity in pattern between one moult and the next there was complete continuity of the underlying physiological processes. The exact nature of this physiological developmental continuity is a nice problem on which we have very little light at the present time. But the author carries his conception of continuity much farther. In his many crossing experiments he found usually a blending result, with a fluid condition and no halting places from character to character. Granting that this may be generally true of species crosses in pigeons, yet the author himself describes cases of sex-linked inheritance and other phenomena which indicate some fixed boundary line between certain characters. We therefore feel that a universal philosophy of continuity is misleading because untrue. The enormous Mendelian literature is not based entirely upon superficial or hasty observation, although such cases no doubt occur. The author would have been on safer ground had he recognised, with Galton, that both continuity and discontinuity exist in Nature, and both are equally worthy of an explanation. We may perhaps look forward to a harmonisation of these two opposing principles on the basis of cell structure.

(4) Several aberrant birds arising in these experiments are described as "mutations." For example, a Zenaida (Fig. 4, *a*) produced a mutant in which the juvenal plumage (Fig. 4, *b*) was more primitive than in the type, but the adult plumage



(*b*) (*a*)

FIG. 4.—(*a*) *Zenaida vinac o-rufa*, normal juvenal plumage. The light apical edge of the feathers is a primitive character in birds. (*b*) Mutant, juvenal plumage, showing a mesial extension of the light apical edge. This condition is a specific character in *C. guinea*.

was normal. This condition was transmitted through five generations in a generic cross. It recalls a type of yellow seedling occurring in maize which, if carefully nurtured, finally grows up into a green plant. Similarly, a Japanese turtle-dove (Fig. 5) produced three partial albinos in her old age. In this case there was also inbreeding. The orthogenetic interpretation assumes that the colour pattern is being progressively reduced, and that albinism is the final condition to which the whole group of pigeons is tending. This being the case, we may expect the reduction series to be hastened in a weakened germ, so that a long step in this direction might be anticipated. Here it would seem possible to find a basis for adjusting the conception of mutation with that of orthogenesis, even in pigeons.

(5) The conception of germinal weakness or strength is one on which Whitman lays great stress, and it is supported by much experimental evidence. Differences in "strength" or develop-

mental power are shown not only in hybrids, but also in pure species. By removing their eggs when laid, the birds can be overworked in reproductive activity, with a corresponding decrease in energy of the offspring. The result is more females and a shorter term of life. Even in normal reproduction there is found to be a gradual diminution in developmental power of the germs throughout the season.

This idea of relative and varying germinal weakness and strength runs through all the work, and will be found difficult to controvert. It is probably but the beginning of a theory of evolution founded primarily, not on morphological, but on energy conceptions.

(6) Another important relationship which was studied in great detail is that between fertility and sex. The problems involved are too many-sided to discuss here. It was found, for example, that while in crosses between closely related species the sexes appear in equal numbers, in inter-

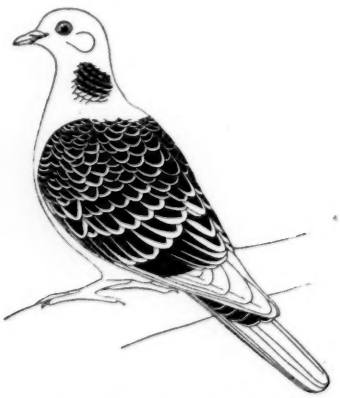


FIG. 5.—The Japanese turtle-dove, *Turtur orientalis*. Believed to represent the primitive colour pattern in pigeons, from which the chequers of *C. livia* were developed by the disappearance of pigment along shaft of feather.

family crosses only or chiefly males are produced. In wide crosses the development may only begin, or it may stop at any stage between hatching and maturity, resulting in short-lived birds. All these and many other results are interpreted in terms of developmental energy, the difference between the sexes being regarded as essentially a difference in metabolic level. This view is in accord with the classical theory of sex of Geddes and Thomson. Some means must be found of harmonising it with the chromosome theory.

(7) The study of voice, instincts, and behaviour in pigeons has added much to the value of the whole work. Whitman's intimate knowledge of pigeons from this side frequently furnishes corroborative evidence of relationships. It also made possible his singular success in crossing many species which had never been crossed before. The differences in the instincts of the reproductive cycle are often surprisingly marked and definite in different species. In a discussion of instinct in relation to intelligence, the author's view is that as instincts become more complex and plastic the possibility of choice finally enters, so that without any added brain structure the organism is encouraged or constrained by circumstances to *learn* to use its privilege of choice.

These notable volumes, two of which are sumptuously illustrated with coloured plates by Japanese artists, will doubtless arouse much discussion. It is to be regretted that an index has not been added, to make their contents more readily available. R. R. G.

THE NITROGEN PROBLEM.[1]

II.

BEFORE the war the United Kingdom produced and exported large quantities of ammonia nitrogen, upwards of 70 per cent. of the home production being, in fact, exported. Indeed, the British export trade in ammonium sulphate was larger than that of any other country. On the other hand, she was entirely dependent upon the Chile product for her nitric nitrogen. Agriculture accounted for the major portion of the home consumption of fixed nitrogen, but this only represented 23·5 per cent. of the total home production and importation. Indeed, in proportion to the total area under cultivation, the United Kingdom uses less artificial nitrogenous fertilisers than any other progressive agricultural country.

The war has had a serious effect upon the home industry. Whereas the estimated output of by-product ammonia in America and of by-product and synthetic ammonia in Germany in 1917 was more than double what it was in 1913, with us it declined in 1914 and 1915, slightly recovered in 1916, and in 1917 showed only an increase of 6 per cent. over the amount in 1913. Our export trade in ammonium sulphate practically ceased in 1917. Countries which formerly imported our sulphate of ammonia are now making their own by-product ammonia. This result is due to the action of the Government in controlling the export and price. As is well known, there has been a remarkable development in agriculture in this country during the last four years, and the home demand for nitrogenous fertilisers has been in excess of the supply. There can be no doubt that both the industrial and the agricultural demand for nitrogen products will continue to increase. The Committee estimates that on the assumption that the present scale of food production is at least maintained, the demand in the near future will probably represent a quadrupling of the average pre-war requirements. Our export trade in ammonia fertilisers will have in future to reckon to a still greater extent with synthetic products. It can only successfully compete by this country itself manufacturing such products. No doubt economies and improvements in existing by-product processes are conceivable and possible, but

[1] "Ministry of Munitions of War. Munitions Inventions Department. Nitrogen Products Committee. Final Report." Pp. vi+357. (London: H.M. Stationery Office, 1919.) Cmd. 482. Price 4s. net. Continued from p. 535.

it is unlikely that low-temperature carbonisation will have any considerable influence on the main result, and attempts to utilise peat and sewage afford no certain promise of success. Although our existing processes have admittedly shown themselves to be a national asset of the greatest value in times of war, they need to be supplemented, in a time of national emergency, by methods which will render this country independent of external supplies of nitrates.

The cost of power is, of course, a vital factor in connection with the establishment of any synthetic process of nitrogen fixation, and to this question the Committee necessarily devoted great attention and with special regard to the conditions of the United Kingdom. It has considered such water-power schemes as appeared practicable, and the cost of obtaining electrical energy from coal. The comparison is complicated by the many complex factors involved, and especially by the uncertainty concerning the future cost of coal and labour. At the same time, it offers an estimate of the cost of a particular water-power scheme which it has investigated, but of which it gives no details, and it is of opinion that for a power of more than 28,000 continuous kilowatts the running cost, under post-war conditions, would be 3·93*l.* per full kilowatt-year, inclusive of capital charges. The only possible chance of obtaining electrical energy from coal at a cost which would compare with this would be by direct firing at a power station operating on a very large scale. This with coal at 10*s.* per ton and an annual load factor of 97·5 per cent. works out at about 4·5*l.* per kilowatt-year of 8540 hours.

After careful consideration of the main features of the various nitrogen fixation processes and of the ammonia oxidation process, in the light of British conditions and requirements, the Committee concludes that (*a*) the *arc* process, in spite of certain disadvantages, viz. its large power requirements, its low electro-chemical efficiency, and the costly character of its chemical plant, would compete with the retort process of obtaining nitric acid so long as the cost of electrical energy was below 9*l.* per kilowatt-year. (*b*) The *calcium cyanamide* process affords a cheaper marketable form of combined nitrogen, so long as electrical energy is below 5*l.* per kilowatt-year, than any other established fixation process, and gives a solid nitrogenous fertiliser as a primary product. The manufacture may be combined with that of calcium carbide and crude cyanides, and, as the raw materials are cheap and abundant in this country, there is good ground for assuming that it would be successful with us, in spite of the relatively high cost of electrical energy. The Committee is of opinion that a steam-power station of 30,000-kw. maximum load is the minimum size that would be justifiable under British conditions. (*c*) The *Haber* process, with pure hydrogen at 2*s.* 6*d.* per 1000 cu. ft., is capable of producing ammonia at a cost below that of any ammonia process as yet established. The Committee, of course, had no opportunity of inquiring into the Claude process, the details of which have only recently become known. Both these processes are the most promising of all the synthetic methods of making ammonia and ammonium sulphate. It is too soon to express any definite opinion as to their relative merits as commercial processes, but it is certain that both of them have a great future.

The *ammonia oxidation* process for making nitric acid, although probably not in its final form, can even now furnish concentrated acid at a lower cost than the retort process from Chile nitrate, and ammonia oxidation converters are well adapted for use in the chamber process of making oil of vitriol. It is not unlikely that such converters will soon supersede the wasteful system of nitre-pots.

It should be stated, however, that the last word has not been said in favour of existing by-product processes. It is pointed out that improvements in the metallurgical coke industry, such as the more rapid replacement of beehive ovens by recovery ovens, and improvements in the existing practice in gasworks, both large and small, would do much to augment the yield and recovery of by-product ammonia, and the Committee was unanimously of opinion that energetic measures should be taken to ensure that industries making such a large annual demand upon our coal reserves should be made to utilise them to the maximum advantage, and it indicates in outline what these measures should be. The waste that has hitherto taken place in the potentiality of coal, as regards both its energy and its products, is a national scandal that ought no longer to be tolerated. Its continuance would be the strongest argument that the advocates of nationalisation could adduce.

Considerations of space prevent any attempt to deal with many other points which have engaged the attention of the Committee, and are set out in detail in its voluminous report, such as the question of the nitrogen problem as it affects other parts of the Empire. The Dominions beyond the seas are rich in latent resources in coal and other raw materials, and some of them possess exceptional water-power facilities, accessible to the seaboard and capable of easy development. Nor have we been able to devote much space to the question as it affects national defence. It must be evident, however, from past experience that, notwithstanding our maritime supremacy, the military situation has been, as the Committee states, fundamentally changed. We must no longer be dependent upon Chile nitrate for the manufacture of explosives. We agree with the Committee that a wise policy in regard to defence can well go hand in hand with a sound economic policy.

The Committee recommends that:—

1. The calcium cyanamide process should be established in Great Britain without delay, either by private enterprise (supported, if necessary, by the Government) or as a public work, and that the scale of manufacture should be sufficient to produce 60,000 tons of cyanamide per annum,

equivalent to about one-eighth of the present home production of ammonium sulphate, the necessary water-power being obtained in Scotland, or from a large steam-power station.

2. That the synthetic ammonia (Haber) process should be established forthwith on a commercial unit scale and extended as rapidly as possible, as a post-war measure up to a minimum manufacturing scale of 10,000 tons of ammonia (equivalent to 40,000 tons of ammonium sulphate) per annum; and it suggests that the factory at Billingham-on-Tees, which the Government, in 1918, decided to erect, mainly for the manufacture of ammonium nitrate, might be utilised for the purpose.

3. That an ammonia oxidation plant should be established in conjunction with the synthetic ammonia factory on a scale sufficient to produce 10,000 tons of 95 per cent. nitric acid, or its equivalent in nitrates, and that the plant should be designed to utilise either synthetic or by-product ammonia.

4. That steps should be taken with the view of conserving and increasing the output of combined nitrogen from existing by-product ammonia industries, of securing the better utilisation of the national resources in coal, and of reducing the consumption of *raw* coal as fuel. (The various steps which it is suggested should be taken to secure these ends are set forth.)

5. The Committee further recommends that certain nitrogen fixation processes—*e.g.* the Häusser process, certain cyanide processes, and sulphate recovery processes—should be systematically investigated on a small works scale. It understands that the question of low-temperature carbonisation of coal is being investigated by the Fuel Research Board. It suggests that the researches on the nitrogen problem initiated during the war should be continued under the auspices of the Government for the general benefit of the country; and that the results of the researches carried on up to the present should be edited, and published at the earliest possible moment, subject to such reservations as may be considered necessary by the Government, members of the Research Staff of the Munitions Inventions Department being allowed to communicate to scientific societies the details of their work, subject to such reservations as may be considered necessary by the Government.

The Committee concludes its report with a recommendation that a co-ordinated policy should be framed by an Imperial authority for safeguarding the future nitrogen requirements of the Empire. It points out that, so far as the United Kingdom is concerned, nitrogen fixation and allied industries will constitute a new "key" industry. The Committee is of opinion that the initiation and development of the industry will require the active support of the Government.

It is not to be anticipated, in the present state of the political position, and in view of the large arrears in its programme of reconstruction with which the Government is faced, that any immediate consideration will be given by it to the Committee's recommendations, or that any practical steps will be taken to give effect to them beyond attempting to dispose of the Billingham-on-Tees property, and possibly permitting the Research Section of the Munitions Inventions Department to continue its investigations. We understand that negotiations on behalf of an important group of firms are in progress for the purchase of the Billingham works. But whether the Haber process or the American modification of it will be carried on there remains to be seen. Within the last few days it has been announced that an influential financial syndicate is about to establish a factory in the neighbourhood of Maryport, West Cumberland, to work the Georges Claude process, which is already in operation at Montereau, near Fontainebleau, by which it is claimed that the production of ammonia is increased fourfold as compared with the Haber process, as worked by the Badische Anilin & Soda-Fabrik at Oppau, near Ludwigshafen. The first unit of the synthetic plant will be of sufficient size to produce the equivalent of 50,000 tons of sulphate of ammonia per annum. If this consummation is reached it will go far to solve the problem which the Nitrogen Products Committee has been considering with such thoroughness and care during the last three or four years.

EXPLORATION IN TIBET AND NEIGHBOURING REGIONS.[1]

COL. LENOX CONYNGHAM has done right good service to the science of geography by compiling in one comprehensive volume the complete story of the early exploration of the great Tibetan uplands before that land of mystery and romance became attractive to European geographers, who evolved the map of Tibet as we now know it on a more scientific basis. It would indeed have been useful if the brief preface to the volume had included a somewhat more detailed explanation of the means and the methods employed by these early native surveyors in those amazing journeys which gave us the first (and sometimes the last) outlines of Tibetan geography, and laid the foundations for subsequent map superstructure. The narratives of the individual explorers are given in chronological order, commencing with the journey of Pandit Nain Singh, in 1865, from Nepal to Lhasa, and terminating with that of Atma Ram, who accompanied our first adventurer, Capt. (now Sir Hamilton) Bower, when he traversed Tibet from Kashmir to China in 1891–2, following a route which was not very far removed from that of Nain Singh in earlier days. Then for the first time were the eyes, not only of geographers, but also of archæologists, opened to the immense wealth of scientific and historical knowledge which was to be gathered in that remote part of Asia.

1 "Records of the Survey of India." Vol. viii. (in two parts). Part i., "Exploration in Tibet and Neighbouring Regions, 1865-79." Pp. xi+213+charts. Part ii., "1879-92." Pp. xi+215-411+charts. (Dehra Dun: Office of the Trigonometrical Survey, 1915.) Price 4 rupees or 5*s.* 4*d.* each part.

For some twelve years the native explorers of the Indian Survey had the field to themselves, and it may safely be said that no Asiatic geographers of the past, not even the Arab adventurers of the Middle Ages, or the Chinese pilgrims of yet earlier times in search of such evidences of their Buddhist faith as were to be found on the frontiers and plains of India, ever established such a remarkable record of geographical accomplishment as did these Lamas and Pandits of Indian Survey history in so short a time. Their success was due primarily to the fact that they were well selected for the special line of exploration which they were expected to follow. Then they were thoroughly well trained in the first elements of geographical reconnaissance by Indian Survey officers.

As a rule their methods were simple, for they included no more than the first principles of traversing on bearings taken by the prismatic compass, distances being measured by pacing, and occasional most valuable checks being derived from latitude observations with the sextant. This involved the use of small instruments which were concealed either in their clothes or in false bottoms to their boxes. A rosary was the convenient means of checking their paces. Considering that many thousands of miles were covered in this way, and that the final reduction of their voluminous records (concealed usually in the lining of their coats) was most satisfactory, no higher and better evidence of the patience and determination of such men as Nain Singh, Kishen Singh (the A–K of the Survey records), or of Ugyen Gyatso could be desired. They were frequently engaged for years on the same quest; they were occasionally caught and enslaved, but almost always managed to save their instruments and their records; and their journeyings carried them across the great plateau to Mongolia and China, and into regions where hitherto no European has followed them.

With the influx of European explorers, started by the remarkable discoveries of Bower, the later stories of Tibetan exploration became public property, but it should be noted that many of the most successful of these later white adventurers have employed native explorers to do the spade work of their geographical mapping, and that with the close of the period indicated in this useful volume (which has conveniently brought together information hitherto scattered and rather difficult to retrieve) the work of the native geographer has by no means come to an end. Another and an even greater volume might follow which should show how much our well-known Tibetan travellers owe to the indefatigable perseverance and the remarkable skill as topographers of their native assistants.

Col. Lenox Conyngham's compilation merely brings together the narratives of the earliest native adventurers, and no book of travel that ever was written contains such a wealth of thrilling personal incident as underlies the simple (and sometimes prosaic) account of these humble Indian workmen. T. H. H.

NOTES.

A SPECIAL meeting of the Royal Society was held on Thursday, January 22, when the Prince of Wales was admitted a fellow, following election by ballot, which took place on May 22, 1919. This election was in pursuance of a clause in the society's statutes which permits any one of his Majesty's subjects who is a Prince of the Blood Royal to be proposed at one of the ordinary meetings by any fellow, provided such proposal shall have been made at a preceding meeting. Under this provision King George V. was elected in 1893 when Duke of York. His Royal Highness was received in the society's vestibule by Sir Joseph Thomson and the officers and vice-presidents, whence, preceded by the mace-bearer, a procession was formed through the ranks of the fellows to the meeting-room. The Prince occupied a seat on the front bench among the fellows. The senior secretary having announced the attendance, his Royal Highness advanced to the president's table and subscribed his name in the charter book, thereupon taking a seat on the left of the president. An attractive discourse was then given by Prof. W. H. Bragg on methods of detecting submarines by sound. Upon its conclusion the Prince thanked the society for his admission, and assured the fellows of his interest in the advancement of scientific research.

DISTURBANCES of wireless messages are commonly known to all operators, and are usually regarded as atmospheric effects. Mr. Marconi, however, in a statement published in the *Daily Mail* of January 27, describes interruptions which occur simultaneously in London and New York, and in which certain long and short signals are repeated more frequently than others, as, for example, the three dots signifying the letter S in the Morse code. In the absence of a physical explanation of these regular and simultaneous interruptions, it is perhaps human, and certainly sensational, to suggest that the signals represent attempts of intelligent beings on another planet, or the moon, to communicate with the earth. The *Daily Mail*, therefore, refers to "recent investigations by Prof. Lowell with his giant telescope" of Martian canals (Prof. Lowell died in 1916), and to Prof. W. H. Pickering, who "has caused extraordinary interest in the United States by recently announcing that he sees signs of life on the moon," though these views have been before the astronomical world for many years, and the phenomena observed admit of other interpretations. The interruptions described by Mr. Marconi are no more wonderful than the magnetic disturbances long registered in magnetic observatories. Such disturbances of the photographic records are often very definite in character, and occur at about the same hour on successive days, while they are also found to occur simultaneously at stations so far apart as Christchurch (N.Z.) and Kew. The magnetic and wireless effects are closely related, but whether they originate in the sun or arise from a common cause operating throughout the solar system has yet to be determined. That they are signals from other worlds is attractive to the imagination, but the hypothesis is more of popular than of scientific interest.

IT is with deep regret that we record the death of Dr. C. R. C. Lyster on January 26 at the age of sixty years. Dr. Lyster held the position of head of the X-ray and electro-therapeutic departments at the Middlesex Hospital during the last seventeen years. Even in quite the early years of radiology Dr. Lyster made extensive use of X-rays in the treatment of disease, especially cancer. It was at this period, when the harmful nature of repeated fractional doses was not known, that he himself sustained damage which afterwards developed into the disease he sought to alleviate in others. Dr. Lyster fully realised the additional risks he ran by continuing his work, but nothing could deter him from pursuing it, and his work of later years should be viewed in the light of a sacrifice on his part to the cause of advance in medicine. Dr. Lyster was president of the electro-therapeutic section of the Royal Society of Medicine for the year 1918–19, and served on its council and on that of the Röntgen Society for a number of years. His publications were few, and provide no adequate guide to the value of his services to medicine, especially to medical radiology. The recent institution of a diploma in radiology and electrology by Cambrige University was largely due to the efforts which Dr. Lyster made in the first instance. Throughout the whole of his work he combined in a rare degree a breadth of outlook and an unselfishness of purpose which ensured a respect for his views and counsel. Of his personal charm and character a wide circle will preserve a permanent memory.

THE Rev. Edmund Warre, D.D., who died at Eton on January 22, the anniversary of the death of Queen Victoria, was a notable and commanding figure in the Victorian age. During his headmastership of Eton, which lasted from 1884 until 1905, many new buildings, including three science laboratories, were added, and science teaching, more particularly with a view to military requirements, was extended and developed. Dr. Warre was in the habit of saying that, like the horse-leech, Madam Science had many daughters, all crying "Give, give"; but he was a generous and wide-minded man, whose own scientific tastes lay in the direction of botanical work. His ruling passion, however, was for the river, and he used frequently to lament that, because his mathematical training had been neglected, he was unable to work out satisfactorily the ideal lines of a racing-boat. Dr. Warre had been for some years an invalid, and he retired from the Provostship of Eton in 1918. No man can have had a wider circle of friends, and he will be remembered with affection and esteem by many men of science.

THE award of the Straits Settlement gold medal, founded by Scottish graduates in the Malay States, to Dr. R. T. Leiper was announced in our last issue. The medal is given for the best thesis for M.D. on a subject of tropical medicine offered during the last five years, and is awarded by the Senate of the University of Glasgow. Dr. Leiper's thesis, for which he gained a Bellahouston gold medal in 1917, comprised an account of the brilliant work which he did on Bilharzia disease in Egypt (1915–16), whither he was sent by the Government as consultant parasitologist and Lt.-Col., R.A.M.C., to investigate the disease and to advise as to preventive measures in connection with the troops. It will be recalled that by his researches Dr. Leiper established the existence of two species of parasites in human bilharziosis, traced their life-history outside the human body in molluscs, and demonstrated the modes of infection, besides elucidating numerous other points. The award of this medal by Dr. Leiper's university is a fitting recognition of an epoch-marking advance in parasitology.

BRITISH botanists have an opportunity of showing practical sympathy with the eminent French bryologist, M. Jules Cardot, who has suffered severely from the effects of the war. Driven from his home at Charleville by the German advance in 1914, M. Cardot had to abandon all his possessions. He has now returned to find that the greater part of his property has been destroyed or removed, including his books and MS. notes and a large portion of his collections. Fortunately, his mounted herbarium of mosses, containing between 30,000 and 40,000 specimens, representing more than 10,000 species, is practically intact. The herbarium is a valuable one, containing the types of a large number of new species described in M. Cardot's numerous monographs of various families and works on the geographical distribution of mosses. It is M. Cardot's wish that his herbarium should find a home in the Paris Natural History Museum, but with his present restricted means he is unable to make a gift of it to the nation, and the museum has not sufficient funds at its command for the purchase. A suggestion has been made by bryological friends, simultaneously in the United States and this country, that if the museum authorities will find half the amount required the remaining half might be raised in Great Britain and in America. The authorities in Paris have gratefully expressed their willingness to agree to such a scheme, and the price of 10,000 francs has been mentioned. The proposal to raise one-fourth of that amount in this country would at the present rate of exchange entail a sum of between 60*l*. and 70*l*. The well-known British bryologist, Mr. H. N. Dixon, is acting as treasurer of the fund, and his address is 17 St. Matthew's Parade, Northampton.

DR. EDWIN DELLER, secretary of the Brown Animal Sanatory Institution, University of London, has been appointed assistant secretary to the Royal Society.

WITH the approval of the Lords Commissioners of the Treasury, Major H. E. Wimperis, R.A.F., has been transferred from the Office of the Crown Agents for the Colonies to the Air Ministry, to take up the position of Head of the Air Navigation Research Section.

WE are informed that the council of the Glass Research Association has appointed Mr. R. L. Frink, Lancaster, Ohio, U.S.A., director of research. The secretary of the association says:—"Mr. Frink has a lifelong experience of the American glass trade and glass research, is well known to the foremost English glass manufacturers, and his appointment is welcomed by the British glass industry."

THE death is announced, in his seventy-second year, of Mr. R. L. Garner, the American author who published a book on "The Speech of Monkeys" in 1892, and afterwards visited the Gaboon, the country of the gorilla, where he stated he lived for some months in a steel cage to study the language of the great apes. On his return to London, early in 1894, Mr. Garner delivered a lecture on his experiences, which attracted a large audience, but clearly showed that science had nothing to expect from his enterprise.

WE regret to record the death on January 24 of Mr. R. F. Wallace, who retired from the Meteorological Office at the close of last year. Mr. Wallace was in his sixty-eighth year, and should have retired some two years ago, but remained in the service during the closing period of the war. He entered the Meteorological Office in 1883, and first served in the marine division. About twenty years ago he took general charge of the meteorological instruments.

INFLUENZA seems to threaten to be prevalent in this country before long, judging by the outbreaks in America and elsewhere. Since the commencement of October influenza has been present to a limited extent in the British Isles. The deaths in the ninety-six great towns of England and Wales have risen from 14 and 20 in the two closing weeks of September last to 70 or 80 deaths per week at frequent intervals during the autumn and winter. In London the deaths rose to 22 in the weeks ending November 15 and 22, but they have not touched 20 in any week since, according to the returns of the Registrar-General to January 17. The highest death-rate is between twenty and sixty-five years of age, the deaths for those ages in the last thirteen weeks being 59 per cent. of the total number.

IN the current number of the *Annales de la Société Royale Zoologique et Malacologique de Belgique* appear the names of ten honorary members who have recently been elected to that society. Among the names are those of Prof. L. Cuenot, Faculté des Sciences, Nancy; Prof. M. Caullery, the Sorbonne, Paris; Dr. A. E. Shipley, Christ's College, Cambridge; Senator B. Grassi, Italy; Prof. E. G. Conklin, Princeton University; and Prof. Th. H. Morgan, Columbia University.

THE annual meetings of the Institution of Naval Architects will be held on Wednesday, March 24, and the two following days, in the hall of the Royal Society of Arts, John Street, Adelphi, W.C.2. The Right Hon. the Earl of Durham, president, will occupy the chair. A gold medal will be awarded by the council to any person not being a member or associate member of council who shall at the forthcoming meetings read a paper which, in the judgment of the council, is deemed to be of exceptional merit.

OWING to the prevalence of diseases in prepared timber, and in view of the impending increase in the use of timber—much, possibly, of immature growth—in building construction, the Science Standing Committee of the Royal Institute of British Architects, under the chairmanship of Mr. Alan E. Munby, has had the question of such defects under review, and Dr. C. J. Gahan, of the Natural History Museum, has been asked, and has consented, to associate himself in an advisory capacity with this inquiry. The committee will welcome any information which seems likely to further such investigations. Correspondence should be addressed to the Secretary, Royal Institute of British Architects, 9 Conduit Street, W.1, and marked "Science Committee."

THE following awards have been made by the council of the Institution of Mining and Metallurgy:—(1) Gold medal of the institution (premier award, and the highest distinction within the power of the institution to confer) to Mr. H. Livingstone Sulman, in recognition of his contributions to metallurgical science, with special reference to his work in the development of flotation and its application to the recovery of minerals. (2) "The Consolidated Gold Fields of South Africa, Ltd." gold medal to Mr. William Henry Goodchild, for his papers on "The Economic Geology of the Insizwa Range" and "The Genesis of Igneous Ore Deposits." (3) "The Consolidated Gold Fields of South Africa, Ltd." premium of forty guineas to Dr. Edward Thomas Mellor, for his paper on "The Conglomerates of the Witwatersrand."

AT the annual general meeting of the Royal Meteorological Society, held on January 21, the following officers and council were elected:—*President:* R. H. Hooker. *Vice-Presidents:* J. Baxendell, F. Druce, Sir Napier Shaw, and F. J. W. Whipple. *Treasurer:* W. V. Graham. *Secretaries:* W. W. Bryant and J. S. Dines. *Foreign Secretary:* R. G. K. Lempfert. *Council:* C. E. P. Brooks, Dr. J. Brownlee, Capt. C. J. P. Cave, J. E. Clark, R. Corless, Capt. G. M. B. Dobson, J. Fairgrieve, Lieut. H. D. Grant, H. Mellish, Dr. J. E. Petavel, M. de Carle Sowerby Salter, and G. I. Taylor. The Symons gold medal awarded to Prof. H. H. Hildebrandsson, of the University, Upsala, was presented on his behalf to the Swedish Minister.

MR. IKBAL ALI SHAH gives in *Folk-lore* for December last (vol. xxx., No. 4) a comprehensive account of the folk-life of Afghanistan, a subject about which little information has hitherto been available. He traces the life of an Afghan from the cradle to the grave, his account of the marriage and death ceremonies being particularly interesting. On the whole, though Mr. Shah is perhaps influenced by his natural prepossessions, he gives a pleasing impression of the family life of the people, and the general result is that, as Afghanistan borders on both Persia and India, the domestic rites of the Afghans have been influenced both by Persians and by the Hindu or Mussulman culture of the Punjab.

IN *Sudan Notes and Records* (vol. ii., No. 3, July, 1919) Dr. C. Crossland treats the question "Comfort and Health in the Tropics." "Remove the mosquitoes and the fevers they carry, and most tropical countries can be made fairly healthy." He gives good advice on clothing. "Air which is already moist can have little drying or consequent cooling effect unless it is in fairly rapid motion. Consequently

what is known as ventilation in Europe is of little use in the tropics, and houses designed in Europe are never, so far as I have seen, sufficiently airy for the Red Sea coast." Hence he lays down, with the help of diagrams, what is his idea of a suitable house. The author does not appear to have any experience of India, where the subject has been carefully investigated. But the paper will be useful to all who intend to reside in the tropics.

MR. H. BOLTON, Director of the Bristol Museum and Art Gallery, in his report for the year 1918–19, points out that the museum suffered from the necessity of exercising a strict economy in order that the changed conditions of the cost of labour, supplies, and museum material may be met as well as possible by the unaltered pre-war income—conditions affecting institutions of this kind throughout the country. But the educational work has been carried on with success, no fewer than 60,000 visits having been made by wounded soldiers during the war period. The important collection of guild banners has been increased by some welcome gifts; Mrs. C. Ryland presented a valuable series of pictures, and Mr. H. Mardon a large collection of European engravings and his extra-illustrated copy of Nichol and Taylor's "History of Bristol," extended to fourteen volumes and containing almost every known illustration and map of importance relating to Bristol.

SIR C. HERCULES READ describes in the January issue of *Man* an ancient Chinese bronze from the collection of Mr. H. Oppenheim. It represents a monstrous mammalian quadruped, winged, with a long neck and a feline head, which seems to be struggling with a snake-like form. Figures of a similar kind are said to have been used as a refrigerator for food, or as a brazier for heating water or wine. Sir C. H. Read remarks that "the practical identity of the Tartar figures and the surrounding animals would further suggest that if one be of the Han dynasty type, the other is also. In any case, the suggestion helps my theory as to the affinities of the Oppenheim bronze, viz. that in some respects it has clear connection with the later Bronze age in the Far East. The architectural treatment of the base is quite un-Chinese, and at the present moment I can think of nothing nearer than Gandhara with which to compare it. Ten years ago such a suggestion would have been thought fantastic, but Sir Aurel Stein's discoveries have reduced it to a commonplace."

DR. J. W. H. HARRISON, continuing his experiments with the Geometrid subfamily Bistoninæ, finds peculiar sex-relationships particularly in inter-generic hybrids of these Lepidoptera (*Journal of Genetics*, vol. ix., No. 1). Occasional inter-sexes, intermediate between males and females, were produced, and in several crosses only males appeared, although all the fertilised ova developed. In such cases the male parent in the cross is found to be "phylogenetically older" than the female. Thus *Nyssia zonaria* × *Lycia hirtaria* yielded males only. A further complication is found in the fact that *hirtaria* has fourteen (haploid) chromosomes, while *zonaria* has fifty-six. An explanation of the results is attempted in terms of intensity of sex-factors.

"NOTES on the Survey of India Maps and the Modern Development of Indian Cartography," by Lt.-Col. W. M. Coldstream, R.E., is the title of a volume recently published by the Survey of India. The author traces the history of map production in India and the development of colour printing. The size of sheets, use of symbols, selection of colours, and lettering and other problems in cartography are discussed at length, and the volume is illustrated by forty coloured plates showing specimens of all the most important maps published by the Survey of India, as well as illustrations of several old maps. The collection of these plates alone makes the volume of great interest.

MILITARY operations in the Libyan desert in 1914–18 gave Dr. J. Ball opportunities of taking the latitude and longitude of several places of which the position had not been accurately determined. These are published by the Egyptian Survey (Survey Department Paper No. 34). The positions determined extend from the Nile west to the Siwa oasis and Jarabub, and south to the oases of Kharga and Dakhla. The position of Bir Terfawi, which had hitherto only been guessed at, was determined by Lieut. Moore, who places the well nearer to Wadi Halfa than had been previously supposed.

THE question of Suess's "sal" and "sima" magmas is dealt with by Dr. Holtedahl in relation to continental margins in a paper on the causes of large earth-movements, which appears in *Naturen*, 1919, p. 266.

MR. F. L. HESS proposes (*Amer. Journ. Sci.*, vol. xlviii., p. 377, November, 1919) a new and useful geological term, "tactite," for the body of rock altered by contact with an igneous mass. The abbreviation rendered possible in descriptions of contact-phenomena by the adoption of so simple a word is at once obvious and welcome to geologists.

MEMOIR 111 of the Geological Survey of Canada, on "The Silurian Geology and Faunas of Ontario Peninsula," is of special interest, since it includes the well-known Niagara group and its development in the Niagara district. Few new species of fossils are described, but the fauna is admirably illustrated by photographs, and two coloured maps are added in a pocket at the end.

ALL known occurrences of platinum in Canada are described and usefully set down upon a general map by Mr. J. J. O'Neill in Part G of the Summary Report of the Geological Survey of Canada for 1918 (issued in 1919). The conclusion is that "Canada certainly has possibilities of becoming one of the world's largest producers of metals of the platinum group." It appears that at present a very large quantity of platinum, here estimated at 50,000 oz. annually, is lost by the absence of proper methods of recovery in placer working.

M. EMILE BELOT (*Revue Scientifique*, 1919, p. 686) begins in the happiest manner a discourse on vulcanicity in general and on an artificial volcanic field of his own manufacture by reminding his audience of the "big Bertha" that assailed their lecture-hall in the Sorbonne. While the usual height attained by the vigorous projection of volcanic material is 8 km. to 10 km., the dust from Krakatoa rose to 27 km. The experimental volcanoes of the "Bertha" type threw projectiles to a height of 30 km. into a layer where atmospheric pressure is reduced to about 1 mm. of mercury, and the horizontal range thus rendered possible was as much as 120 km. Though the conception was that of a Jules Verne, we must remember that its brilliant realisation was due to the scientific thoroughness of the Germans. M. Belot goes on to show that the lunar crater-rings can be accounted for by normal volcanic projection *dans le vide*, and he then describes and illustrates a model volcano that derives its water from the percolation of an artificial sea.

AT the end of the article upon the Physical and Optical Societies' Exhibition, in the issue of NATURE for January 15, reference was made to the comparative absence of simple forms of apparatus for teaching purposes. The Zenith Manufacturing Co. showed a representative series of its regulating resistances and controllers of very simple form, and the manager of the electrical department writes to say that a special aim is made at instructional needs. We are aware that the company devotes much attention to the details of rheostats for electrical testing, but this affects very slightly the point of the paragraph in question, namely, the desirability of making all apparatus for use in schools and colleges so simple that the principle can be readily understood.

AN important paper by Otto Hahn and Lise Meitner on "The Genesis of Actinium" appeared in the December 1 issue of the *Physikalische Zeitschrift*. In 1908 Boltwood examined a number of uranium minerals, and found that the ratio of their actinium and uranium contents was constant—a result which indicated a genetic connection between actinium and uranium. From these results Rutherford calculated that 8 per cent. of uranium disintegrates along the actinium series. In 1917 Fussler found a value somewhat less than 8 per cent., though only three values were obtained, and these vary as much as 60 per cent. St. Meyer and Hess re-examined the question in 1919, and found a constant relation Ac : U for a set of uranium minerals from various parts of the globe. Hahn and Meitner separate the eka-tantalum [called prot-actinium (Pa) in Germany] from Joachimsthal pitchblende, and compare the total α-ray ionisation from this product with that due to the uranium in the pitchblende. Three methods of separating the eka-tantalum were used, both solutions and residues being examined. The authors find that only 3 per cent. of uranium disintegrates along the actinium series, and the probable error in their results is 10 per cent. This result is in accord with the work of Antonoff and of Hahn and Meitner on UY, which appears to be the mother of eka-tantalum. These workers found that the branch ratio of UY to uranium was about 2 per cent. Hahn and Meitner discuss the available evidence, and conclude that the actinium series originates from UII according to the scheme

$$\text{UII} \xrightarrow[\alpha]{} \text{UY} \xrightarrow[\beta]{} \text{Eka-Ta} \xrightarrow[\alpha]{} \text{Ac},$$

which agrees with that suggested by Soddy in the Trans. Chem. Soc. (vol. cxv., p. 1, 1919). The atomic weight of actinium would thus appear to be 226.

FROM the annual report of the Government Chemist for the year 1918–19 (Cmd. 419) it appears that the total number of samples analysed at the Government Laboratory was 289,180. This represents an increase of more than 20,000 compared with the previous year. Owing to the cessation of hostilities and the subsequent demobilisation of a part of the combatant forces, about 16,000 fewer samples were analysed at the central laboratory; but, on the other hand, the partial revival of trade led to a considerable increase in the number of samples of wine examined, and many more samples also were analysed for the Food Controller and the Air Board. Among other items of interest in the report, two unusual instances of the contamination of foods with metallic poisons may be noted. In one case chocolate sweetmeats were found to contain mercury; this was traced to the metal trays used in the processes of manufacture. In the second instance pastry made from self-raising flour contained antimony, due to the use of tartar emetic as a substitute for cream of tartar instead of the acid phosphate of lime intended to be used as a "tartar substitute."

HORSE-CHESTNUTS have in recent years been utilised for the production of acetone and normal butyl alcohol by a special process of fermentation. The distillate yields a "mixed oil," of which about one-third consists of acetone and the remainder is the butyl alcohol. In the Journal of the Society of Chemical Industry for December 31 Mr. A. Gill gives an account of some experiments carried out at H.M. Factory, King's Lynn, in studying certain aspects of the fermentation. Outstanding features of the operations were (1) frothing and (2) slowness; these were attributed to the presence of æsculin or æsculic acid—a bitter, saponin-like substance which, besides producing froth, is apparently inimical to the development of the special micro-organisms employed. The æsculin can be extracted by treatment of the nuts with water or alcohol. The mature nuts contain about 12·5 to 14·5 per cent. of husk, and immature specimens may have nearly double this proportion. It has been stated that, for successful fermentation, the husk must be completely removed; this was not found to be necessary, though it is an advantage to remove as much as possible, since an excessive quantity retards the fermentation. About 19 per cent. of "mixed oil" was yielded by the nuts.

LLOYD'S shipbuilding returns for the quarter ended December 31 last—commented upon by *Engineering* for January 16—indicate that Great Britain has now regained her foremost position in the world of ship-

building, having 757 vessels under construction, with an aggregate gross tonnage of 2,994,249. This figure is 27,734 tons in excess of the tonnage now in hand in the United States. In all other countries of the world, including the United States and the British Dominions, but excluding Germany (for which country the figures are not yet available), there are 1381 vessels, making 4,867,114 tons in all; so that British tonnage building now amounts to more than 38 per cent. of the world's total. Our shipbuilding industry is thus in a highly satisfactory condition. More than one-third of the total British tonnage now under construction is building in Clyde shipyards.

An interesting paper on radio direction and position finding was read by Capt. H. J. Round to the Institution of Electrical Engineers on January 14. Capt. Round gave a history of the development of the radio goniometer for war purposes which took place immediately war broke out. The record of the difficulties that were overcome is instructive. It was soon found out that the German Navy directed its Zeppelin fleets by direction-finding from land stations. On several occasions, however, when there were nine or ten Zeppelins in a raid all doing their utmost to communicate with their base stations for bearings the German messages got into a hopeless tangle. Our Naval Intelligence operators believed that one special German operator was so skilful that whenever he took control everything proceeded smoothly. The Germans had two radio phare stations which enabled their Fleet and submarines to determine their positions in the North Sea without the necessity of transmitting signals. In each station there was a rotating frame continually sending messages and giving a special zero signal once every revolution. Any operator noting the time-interval between the zero signal and the instant at which the received signal was a minimum could tell at once the angular position of the ship with respect to the station. Doing this for both stations, the position of the ship was determined. During night-time many anomalous results were obtained when direction-finding, the reasons for which have not yet been satisfactorily explained.

Messrs. A. and C. Black, Ltd., announce "Insect Life," by C. A. Ealand, illustrated, and a new edition of "Studies in Fossil Botany," by Dr. D. H. Scott, part i., Pteridophyta, illustrated. *Messrs. Crosby Lockwood and Son* promise "Oils, Fats, and Waxes: Their Manufacture, Refining, and Analysis, including the Manufacture of Candles, Margarine, and Butter," by Dr. G. Martin; "Applied Chemistry for Technical Students," by Dr. C. K. Tinkler and H. Masters; and "The Principles of Air Navigation," by J. E. Dumbleton. The *S.P.C.K.* is bringing out an edition of Clerk Maxwell's "Matter and Motion," revised and brought up to date by Sir Joseph Larmor; also the following new books: "Archimedes," by Sir Thomas L. Heath (in the Pioneers of Progress: Men of Science Series); "The Nature-Study of Plants in Theory and Practice for the Hobby-Botanist," by T. A. Dymes; and "The Book of the Sea-shore," by W. P. Pycraft (the first of a new series entitled The Nature Lovers' Library).

OUR ASTRONOMICAL COLUMN.

NEW COMET 1920a.—A comet of the 10th magnitude has been discovered by Señor Comas Sola at Barcelona. It was photographed by Mr. Wilson at Carleton College Observatory, Northfield, Minnesota, U.S.A., on January 20d. 15h. 51·8m. G.M.T. R.A. 7h. 57m. 40·5s., N. decl. 21° 40′ 54″, referred to the equinox of 1920·0. No information is to hand about its motion. The comet's appearance is almost stellar.

SPECTRUM OF COMET BRORSEN-METCALF.—Pubs. Astr. Soc. Pac. for December contains an account by Prof. Slipher of the spectrum of this comet photographed at Flagstaff on October 17. It resembles that of comet *b* 1914 (Zlatinsky) fairly closely. The third and fourth carbon bands and the first, second, and third cyanogen bands are shown, also six unidentified lines between 4016 and 4074. There is also a faint continuous spectrum.

THE FIREBALL OF JANUARY 16.—A few additional observations of this brilliant object have come to hand, and they prove it to have been of a very exceptional character. At Diss, in Norfolk, the streak it left remained visible for fifteen minutes.

The height of the meteor was from about 52 to 44 miles, and its velocity 15 miles per second. Its course at first lay above Saffron Walden, whence it travelled to above Watford, and then disappeared. Its radiant point appears to have been in the northern region of Cancer, which was not far above the north-east horizon at the time of the meteor's apparition.

This particular part of the sky seems to be the focus of emanation of many fine meteors in January, but they do not appear to favour any particular date. Thus on January 1, 1913, January 21, 1898, and January 29, 1905, bright meteors were traced to the same point, and it has also been conspicuously active in the months of November and March.

OPEN STELLAR CLUSTERS.—Dr. Harlow Shapley has extended his studies of the globular clusters to include the more widely extended clusters chiefly found in the Galaxy (Proc. Nat. Acad. Sci., Washington, August, 1919). He determines the distances of these objects by methods similar to those employed for the globular ones; the distances range from 60 parsecs for the Pleiades to 16,000 parsecs for one cluster and 14,000 parsecs for four others (1 parsec=3¼ light-years). The average of the seventy clusters discussed is 6000 parsecs. Their centroid is distant some 3000 parsecs from the sun towards galactic longitude 270°. Since these clusters would seem to be embedded in the galactic star-clouds, these results would indicate a greater distance for the latter than that which was until lately thought probable.

Dr. Shapley is inclined to abandon his earlier view that the globular clusters cannot exist in the galactic plane, and break up as soon as they enter it. He realises the cogency of the evidence that there is much absorbing matter in this plane, which conceals objects lying beyond it. He still thinks that the open clusters are the remnants of former globular ones, but does not postulate such a sudden transformation from one type to the other as he did at first.

The Astronomer Royal and Mr. Melotte give some details about one of these veiled regions, which lies in the constellation Taurus (Monthly Notices R.A.S., November, 1919). Since the paucity of stars in the region is the same for all magnitudes, it is concluded that the obscuring cloud is comparatively near us. This diminishes the difficulty of the great mass that would be required if the cloud were more remote.

PARIS ACADEMY OF SCIENCES.

PRIZES PROPOSED FOR 1921.

Mathematics.—The Francœur prize (1000 francs), to the author of discoveries or works useful to the progress of pure or applied mathematics.

Mechanics.—The Montyon prize (700 francs), for the invention or improvement of instruments useful to the progress of the mechanical arts; the Poncelet prize (2000 francs), to the author (of any nationality) of the work most useful to the progress of applied mathematics; the Boileau prize (1300 francs), for new researches concerning the motion of fluids (if theoretical, experimental confirmation is required); the Henri de Parville prize (1500 francs), for original work in mechanics; the Pierson-Perrin prize (5000 francs), for a discovery in mechanics.

Astronomy.—The Lalande prize (540 francs), for the most interesting observation or memoir most useful to the progress of astronomy; the Benjamin Valz prize (460 francs), to works conforming to the same conditions as the Lalande prize; the Pierre Guzman prize (100,000 francs), for the discovery of a means of communicating with a celestial body (excluding Mars); the G. de Pontécoulant prize (700 francs), for encouraging research in celestial mechanics.

Geography.—The Gay prize (1500 francs), for a memoir on the most recent improvements introduced into geodesy; the Tchihatchef foundation, for the assistance of explorers in the less known parts of Asia.

Navigation.—The prize of 6000 francs, for progress of any nature tending to increase the efficiency of the French naval forces; the Plumey prize (4000 francs), for improvement in steam-engines or any other invention contributing to the progress of steam navigation.

Physics.—The Gaston Planté prize (3000 francs), for the author of a discovery, invention, or work important in the domain of electricity; the Hébert prize (1000 francs), for a treatise or discovery useful for the popularisation or practical use of electricity; the Henri de Parville prize (1500 francs), for original work in physics; the Hughes prize (2500 francs), for an original discovery in physical science, especially electricity and magnetism or their applications; the Clément Félix prize (2500 francs), for facilitating the continuation of researches concerning the applications of electricity.

Chemistry.—The Montyon prize (Unhealthy Trades) (a prize of 2500 francs and a mention of 1500 francs), for the discovery of a means of rendering some mechanical art less unhealthy; the Jecker prize (10,000 francs), for work in organic chemistry; the Cahours prize (3000 francs), for encouraging young workers already known by their chemical researches; the Berthelot prize (500 francs), for researches in chemical synthesis; the Houzeau prize (700 francs), for a young deserving chemist.

Mineralogy and Geology.—The Cuvier prize (1500 francs), for the most remarkable work in mineralogy and geology; the Delesse prize (1400 francs), for a work on geological or mineralogical science; the Victor Raulin prize (1500 francs), for facilitating the publication of works relating to geology and palæontology; the Joseph Labbé prize (1000 francs), for geological work or researches contributing to the development of the mineral resources of France, its colonies and its protectorates.

Botany.—The Desmazières prize (1600 francs), for the best work on Cryptogams published during the preceding year; the Montagne prize (1500 francs), to the author or authors of important works or discoveries on cellular plants; the Jean Thore prize (200 francs), for the best memoir on European algæ, mosses, lichens, or fungi; the de Coincy prize (900 francs), for a work on Phanerogams; the Jean de Rufz de Lavison prize (500 francs), for work on plant physiology.

Anatomy and Zoology.—The Da Gama Machado prize (1200 francs), for the best memoir on the colour of animals; the Savigny prize (1500 francs), for the assistance of young travelling zoologists, not receiving Government assistance, who make a special study of the invertebrates of Egypt and Syria.

Medicine and Surgery.—The Montyon prize (three prizes of 2500 francs, three honourable mentions of 1500 francs, and citations), for improvements in medicine or surgery; the Barbier prize (2000 francs), for a valuable discovery in surgery, medicine, pharmacy, or in botany in relation to the art of healing; the Bréant prize (100,000 francs), for the discovery of a cure for Asiatic cholera or of a means of eradicating it; the Godard prize (1000 francs), for the best memoir on the anatomy, physiology, and pathology of the genito-urinary organs; the Mège prize (10,000 francs), to the author who continues and completes the essay of Dr. Mège on the causes which have retarded or favoured the progress of medicine; the Bellion prize (1400 francs), for discoveries profitable to the health of mankind or for the amelioration of the human species; the Baron Larrey prize (750 francs), to a physician or surgeon (Army or Navy) for the best work dealing with military medicine, surgery, or hygiene; the Argut prize, for a discovery of a means of medically treating a disease hitherto amenable only to surgery.

Physiology.—The Montyon prize (750 francs), for work in experimental physiology; the Lallemand prize (1800 francs), for work on the nervous system; the Philipeaux prize (900 francs), for experimental physiology; the Fanny Emden prize (3000 francs), for the best work treating of hypnotism, suggestion, and in general of physiological actions exerted at a distance from the animal organism.

Statistics.—The Montyon prize (one prize of 1000 francs, two mentions of 500 francs), for statistical researches.

History and Philosophy of Sciences.—The Binoux prize (2000 francs), for work on the history and philosophy of science.

Medals.—The Arago medal, awarded at the discretion of the Academy; the Lavoisier medal, for eminent work in chemistry; the Berthelot medal, with each prize in chemistry awarded annually.

General Prizes.—The prize founded by the State (3000 francs)—subject proposed for 1921: to establish a methodical classification of the vascular palæozoic plants; the Le Conte prize (one prize of 50,000 francs, encouragements), for notable discoveries in mathematics, physics, chemistry, natural history, medical science, or new practical applications of these sciences; the Jean Reynaud prize (10,000 francs), for original work in science; the Baron de Joest prize (2000 francs), for work in physical science; the Parkin prize (3400 francs), for work on the relations between volcanic action and abnormal atmospheric disturbances; the Saintoin prize (3000 francs), for contributions to the mathematical sciences; the Henri de Parville prize (1500 francs); the Lonchampt prize (4000 francs), for the best memoir on diseases of man, animals, or plants from the point of view of the introduction of mineral substances in excess as the cause of these diseases; the Henry Wilde prize (one prize of 4000 francs or two of 2000 francs), for discovery or work in astronomy, physics, chemistry, mineralogy, geology, or experimental mechanics; the Gustave Roux prize

(1000 francs), for a young French scientific worker; the Thorlet prize (1600 francs).

Special Foundations.—The Lannelongue foundation (2000 francs), to one or two persons in need of assistance belonging either themselves or through their parents to the scientific world; the Laplace prize, to the first pupil leaving the Ecole Polytechnique; the L. E. Rivot prize (2500 francs), between four pupils leaving each year the Ecole Polytechnique.

Research Foundations.—The Trémont foundation (1000 francs); the Gegner foundation (4000 francs); the Henri Becquerel foundation (3000 francs); the Bonaparte foundation, for assisting researches by workers who have already given proofs of their capacity and lack sufficient resources to undertake or pursue their investigations (minimum grant, 2000 francs); the Loutreuil foundation (125,000 francs); the Charles Bouchard foundation (5000 francs), for the assistance of researches in medicine or physiology.

APPLIED PLANT MORPHOLOGY.

THE importance of a knowledge of the special physiology of a crop plant in attempting to improve the yield or quality of the product needs no demonstration. The case for the study of the morphology of the plant is no less clear, and is reinforced by the fact that the two lines of investigation should go hand in hand. There are numerous familiar instances where successful cropping depends upon the correct understanding of morphological principles, and those botanists wise enough to reflect upon the lore of the intelligent practical man are aware that the knowledge possessed by him of the essential morphology of the plants with which he deals is frequently of no mean order.

There can be little doubt that fuller investigation of the morphology of economic plants (and especially of those of the tropics) would be profitable from both the scientific and commercial points of view. An example of such work is afforded by the fourth of Dr. C. A. Barber's memoirs on Indian sugar canes, in which he deals with the tillering or underground branching of the plants (Memoirs of the Department of Agriculture in India: "Studies in Indian Sugar Canes," vol. x., No. 4, June, 1919). Since in the sugar cane (Saccharum) the crop comprises aerial stems derived from the branching of the underground rhizome, the desirability of a full knowledge of the methods of branching and of the factors regulating the process is evident. By careful organisation Dr. Barber and his assistants have dissected and examined a large series of canes (both adult plants and seedlings), and the results so far obtained are of considerable interest and promise.

The chief classes of canes occurring in India include "thick" canes obtained from tropical sugar-growing countries, and Indian cultivated canes, together with wild Saccharums not used for sugar production. The results of the research show that branching in the various groups, from the wild Saccharums to the thick tropical canes, is of the same nature, but of very different degree. Taking a to represent main shoot, and b its branches, c branches of b, and so on, Dr. Barber arrives at a series of formulæ for the structural composition of the clumps at crop time varying from $a+mb+c$ in the thick canes to $a+mb+nc+nd+me+f$ in the wild Saccharums; while the different groups of Indian canes can be arranged in a series between these two extremes. The difference in form and size between the branches of different orders in the same plant have also been carefully studied. The general tendency is for the later branches to be successively thicker, to have longer joints, and to show greater curvature at the base. The characters of the branches of different orders are found to be so definite that the harvested canes can be easily separated at the mill and classified into early and late canes. This opens up a new line of work, since it becomes possible to examine these different classes of canes separately at the mill and to ascertain their relative sugar content and milling qualities. A further point of practical interest arises in connection with this question. The differences exhibited by canes of varying ages in the same clump are often much more marked in clumps raised from seedlings than in those grown from cuttings. The question as to whether this variation is handed on when the seedling is propagated vegetatively is not yet definitely known, and experiments are being conducted to determine this point, which is of considerable importance in the proper selection of seedlings.

The factors influencing the amount of tillering in a plant are, of course, both inherent and external. Different species and varieties, as well as seedlings from the same parents, differ widely, but such differences are complicated and often masked by others brought about by variations in environment which in the case of the sugar cane appear to be translatable into terms of amount of food available. Dr. Barber points out that light, spacing in the field, moisture, soil constituents, and manuring appear to be the chief controlling factors, and of these he regards the light as "probably the most important limiting factor in the production of the greatest number of canes per acre." The results obtained in the investigation raise the hope that it may be found possible to develop the work along the lines indicated by Dr. Barber.

THE ROYAL SOCIETY OF WESTERN AUSTRALIA.[1]

WESTERN AUSTRALIA has followed the other Australian States in the development of its senior scientific society into a Royal Society, and has issued the first four volumes of the Journal in its new form. Thanks to the enlightened support of the State, which undertakes the printing and publication, the society is able to issue a better journal than would be possible if it were dependent on its still small roll of members. The society has started well owing to the cordial co-operation of the new and democratic local university with the scientific services of the State. The first four presidents have been Profs. Dakin and Ross, Mr. Gibb Maitland (the Government Geologist), and Mr. Montgomery (the Government Mining Engineer).

As the reorganisation of the society marks a new start, the journal appropriately includes some synopses of existing knowledge of Western Australia; thus Mr. Alexander begins an interesting series of papers on the early history of Australian zoology, and he also contributes a list of the Orthoptera; Mr. Hedley has compiled a useful catalogue of Westralian Mollusca; and the third volume is mainly occupied by W. V. Fitzgerald's memoir on the botany of Kimberley, including the description of two new genera and eighty-eight new species. In the presidential addresses Prof. Dakin deals with vitalism, adopting a non-committal conclusion, but being quite unconvinced that there is in life any non-material factor; and Prof. Ross discusses the problems of national scientific organisation and education in the light of

[1] Journal and Proceedings of the Royal Society of Western Australia. Vol. i. Pp. xxx+251+16 pls. (1914-15.) Vol. ii. Pp. xv+112+7 pls. (1915-16.) Vol. iii. Pp. xii+227+2 pls. (1916-17.) Vol. iv. Pp. xii+54+1 pl. (Perth, W.A., 1916-19.) Price 5s. each.

the lessons of the war and offers some illuminating personally collected information.

Mr. Gibb Maitland begins his address with the unexpected claim that geology has nothing to do with war, ignoring the many millions that might have been saved had geologists been employed earlier on our side; the Germans, of course, had a large geological staff at the beginning. Mr. Maitland's address is devoted to the problems connected with the Nullagine formation, and his most generally interesting conclusion is that the scratched stones found in it are not, as has been claimed by some Australian geologists, evidence of an early glaciation, but are due to friction during earth-movements. Mr. Montgomery's address is a new statement of his view that the level surface of the plateau of Western Australia is a plain of marine denudation, and that the escarpments, locally known as "break-aways," are sea-cut cliffs. Mr. Montgomery's arguments are, as usual, interesting, ingenious, and fair. It is important to remember that a geologist who knows the arid regions of Australia so intimately as Mr. Montgomery should have arrived at conclusions as to wind-action so different from those adopted in Africa. The view that in recent times nearly all Western Australia was covered by the sea does not explain the restriction of the marine deposits to a relatively narrow band or the change in the topography above their margin. These deposits have a wide extension in the zone seaward of Norseman; the limestones there he accepts as Miocene.

The paper by Messrs. Jutson and Simpson in vol. ii. on the geology of Albany gives further evidence of these marine deposits, as their "Plantagenet beds" are a narrow coastal series ending inland on the slope of the ancient plateau. The marine origin of the "break-aways" is rejected by Messrs. Talbot and Clarke (vol. iii., p. 79) in their valuable contribution to the geology of the little-known country toward the eastern frontier. These authors claim the discovery of an upper Cretaceous or early Kainozoic glaciation in the Wilkinson Range (lat. 26° S.) on the basis of a bed with striated boulders, which, as they recognise, must have been formed by icebergs in shallow water. The evidence for the age of this boulder bed seems, however, quite inadequate. The chief contribution to anthropology is by Mr. W. D. Campbell on the natives of Sunday Island, who make their boomerangs of tank-iron and obtain their firewood from the mainland, although the author describes the wide intervening channel, owing to its fierce currents, as "dangerous to small craft."

The treasurer of the society, Mr. Allum, of the Royal Mint, Perth, discusses the decimalisation of currency in a paper which conveys a warning how strongly some authorities feel against it. He quotes the view of the *Engineering and Mining Journal* of New York that the compulsory adoption of the metric system would be a "calamity of the first order." Mr. Allum is less emphatic, but he is opposed to the decimal system, as its advantages may not be equalled by its drawbacks, and holds that if it be adopted the sovereign should be the standard of value, and the shilling should be retained and divided into ten pence.

J. W. G.

A NEW DEVELOPMENT IN AGRICULTURAL RESEARCH.

ALL interested in agricultural progress will welcome as one of the most significant events in the history of British agriculture the establishment of a research department by the Olympia Agricultural Co., Ltd.

The company, under the chairmanship of Mr. Joseph Watson, is farming on a scale probably unprecedented in this country, having purchased for its operations agricultural estates totalling practically 20,000 acres in the counties of Yorkshire, Northamptonshire, Cambridgeshire, Suffolk, Warwickshire, and Wiltshire. The research department will exercise advisory functions in connection with the farming operations of the company, but its primary object is to conduct research in various branches of agricultural science and practice for the general welfare of British agriculture, to which end liberal financial provision for its activities has been made.

The direction of the department has been assumed by Dr. Charles Crowther, lately professor of agricultural chemistry in the University of Leeds and director of the institute for research in animal nutrition in that University, who will continue and extend his experimental work in that subject.

Plant-breeding research will be a further prominent feature of the department's activities, under the direction of Capt. Hunter, lately in charge of the plant-breeding work carried out in Ireland under the Department of Agriculture and Technical Instruction; whilst provision has also been made for research on soil problems and plant nutrition under the direction of Capt. C. T. Gimingham, late chemist to the agricultural research institute of the University of Bristol.

The headquarters of the department have been located on the company's estate of some 2700 acres at Offchurch, near Leamington, where the ancient mansion of Offchurch Bury is being adapted to provide the necessary laboratories, etc., which are now approaching completion. From this centre experimental work with crops and stock on all the company's estates will be carried out under the general supervision of Capt. F. H. Billington, late of the staff of the Irish Department of Agriculture.

It is the desire and intention of Mr. Watson and his co-directors that the department shall be an "agricultural research station" in the fullest sense of the term, and that the results of its work, in so far as they may be of general interest, shall be made fully available to the general body of British agriculturists.

For some time the activities of the department must necessarily be directed to the experimental work essential to the establishment of a sound basis for its advisory work, but this is bound to produce much information of general interest.

The enhanced appreciation of the importance of research to British industries is one of the most significant effects of the war, and it is gratifying to find that British agriculture, despite its traditional conservatism and suspicion of academic "theory," is not to lag behind other industries, and a good omen that it should contain in its ranks men so alive to the value of research as to provide for it within the industry without the stimulus of subvention from the public purse.

MATHEMATICAL STATISTICS.[1]

PARTS III. and IV. of the twelfth volume of "Biometrika" contain papers of interest to all classes of statistician. Those especially attracted by work on the general mathematical theory of probability will welcome the continuation of Prof. Tchouproff's paper on the "Expectation of the Moments of Frequency Distributions." It will be agreed that the notation of mathematical expectation offers certain ad-

[1] "Biometrika." A Journal for the Statistical Study of Biological Problems. Vol. xii., Parts iii. and iv. Pp. 185-376+iv+viii plates. (London: Cambridge University Press, November, 1919.) Price 20s.

vantages over the forms of expression more commonly adopted in this country, but Prof. Pearson does well to point out that the supposed fundamental distinction of method claimed by some Continental writers is non-existent. He himself contributes a very interesting paper on a method of generalising Tchebycheff's first theorem. He finds that the method of approximating to the limits of a probability is unlikely to be of much practical value in the classes of function of usual occurrence. This result does not, of course, deprive Tchebycheff's work of its interest in permitting of the establishment of Bernoulli's theorem and of Poisson's generalisation of that theorem by elementary methods.

Papers of importance both to the student of theoretical statistics and to the practical computer are those of Miss Pairman and Prof. Pearson on the correction of the moment coefficients in limited range frequency distributions, of "Student" on deviations from the Poisson limit to the binomial in actual data, and an editorial, entitled "Peccavimus," correcting errors in various published formulæ.

Those who are engaged in psychological investigation will turn to Dr. G. H. Thomson's memoir on psycho-physical curves and to the same author's discussion of hierarchical order among correlation coefficients, a subject to which other recent papers have been devoted. In the miscellanea and in a co-operative study of the eggs of the common tern, the biometrician will find much to interest him. It is invidious to cite any one paper as deserving of special praise, but, from the point of view of practical statistics, the discussion of the correction of moment coefficients in the cases to which the classical method of Sheppard does not apply is of chief interest. The volume includes a touching tribute to the memory of Dr. Charles B. Goring, whose untimely death has deprived criminology of one of its most devoted and skilful workers.

THE KINEMATOGRAPH IN SCHOOLS.

THE use of the kinema for schools, and not merely for school children, has been definitely carried a few stages nearer realisation by two recent developments which were brought to the notice of teachers attending the annual meeting of the Geographical Association. In the first place, a portable instrument at the fairly reasonable price of 60*l.* is now on the market. The case itself is fireproof; the lamp is in one separate fireproof chamber within the case, and the film is contained in another, all except the four inches or so actually in the gate; while the instrument is operated by pressing two or three buttons on the outside. The adaptation of the kinema to the class-room in this way has two incidental advantages which are in themselves very great advances. Owing to the fact that the light required is not nearly so strong as for a hall, (1) the instrument can be run off one of the lighting points in the ordinary lighting circuit, and (2) the reduction in light is accompanied by a reduction in heat, so that the film can actually be stopped for some minutes for discussion by the class.

Secondly, the provision of the films seems to be in process of being placed on a more satisfactory basis. Films were used during the war for the instruction of soldiers, and the kinema takes its place in the university, notably in the instruction of medical students. The difficulty in the past has been to know what there was to choose from, and how to choose what one wanted. It is not easy to choose lantern-slides, and it is less easy still to choose films. It cannot be said that this difficulty is wholly met, but the establishment of the Community Motion Picture Bureau goes a long way towards meeting it. There is, at any rate, somewhere to go to inquire whether that exists which one desires, and there is a central body which will gradually learn what it is that schools demand, and with the demand will come the supply. The firm receives films and edits them to make them more or less suitable for schools. One of the sessions of the recent annual meeting of the Geographical Association was taken up by a demonstration by Capt. Hodges of the value of the kinema in the teaching of geography. The films showed varied greatly in quality; the most ambitious, an American film dealing with the life-history of a volcano, was the least successful for several reasons, the most fundamental of which was that it suffered from the distinctly American failing of being non-regional. Other films, dealing with Egypt and the Nile, lumbering, and coffee culture in Java, could very easily be fitted without any jars into geography courses. This is, perhaps, not all that is desired, but it shows, at any rate, that the problem is being tackled, and that there is every prospect of a satisfactory solution ere long.

IRRIGATION IN EGYPT.

WE had occasion in NATURE of September 18 and October 9 last to allude to the controversy which has arisen out of the proposals put forward by the Egyptian Government, under British advice, for the development of the agricultural districts of Egypt and the Sudan by means of additional irrigation works on a very extensive scale. The controversy culminated in the appointment of a Foreign Office Committee, which sat in London to inquire into the charges brought by Sir William Willcocks against the Egyptian Public Works Department. The Committee's findings exonerated the Department, but failed to satisfy Sir William, who forthwith reiterated and amplified his accusations with increased vehemence. Criticism so trenchant and persistent from an engineer of undoubted standing and experience could not be ignored, and now it has been decided to submit the whole question to an International Commission consisting of three members—an irrigation engineer, nominated by the Government of India, as president; a British physicist, nominated by the University of Cambridge; and an irrigation engineer, nominated by the Government of the United States. The terms of reference are:—"To advise the Egyptian Government upon the projects prepared by the Public Works Department, with a view to the further regulation of the Nile for the benefit of Egypt and the Sudan, and in particular to examine and report upon the physical data upon which the projects rest, and to report upon the propriety of the manner in which, as the result of these projects, the increased supply of available water thereby provided will be allocated at each stage of development between Egypt and the Sudan, and to advise as to the apportionment of the cost as between Egypt and the Sudan." In a matter so seriously affecting the welfare and development of two important countries, it is to be hoped that the decisions arrived at by the Commission will be such as to command a general consensus of expert approval.

The Cairo correspondent of the *Times* states, in a message published in the issue of January 23, that the Commission is constituted as follows:—Mr. F. St. John Gebbie, Chief Engineer, Bombay, who was last engaged on the Sukkur barrage scheme—nominated by the Indian Government (chairman); Dr. G. C. Simpson, meteorologist at Simla—nominated by Cambridge University; and Mr. H. T. Cory, who directed the Salton sea works, California, in 1906—nominated by the American Government. Mr. J. L. Capes, of the Egyptian Ministry of Education, will be secretary of the Commission.

VERTEBRATE REMAINS IN THE CAVERNS OF GRIMALDI.

PROF. MARCELLIN BOULE has completed his studies of the remains of vertebrate animals found with primitive man in the caverns of Grimaldi, and the final results of his work have just been published as the concluding part (fasc. iv.) of the first volume of the Prince of Monaco's "Les Grottes de Grimaldi (Baoussé-Roussé)." The new instalment deals with the Carnivora, Insectivora, Cheiroptera, and Rodentia, and various fragments of birds and lower vertebrates, and ends with a valuable general summary. Besides the technical descriptions of the fossils, illustrated by beautiful plates in heliogravure, Prof. Boule continually introduces short discussions of the relationships and distribution of the various animals with which he deals, adding several maps and some genealogical diagrams. He has therefore produced a most interesting and readable treatise on the European Pleistocene vertebrate fauna, which we commend to the notice of both geologists and zoologists. He specially emphasises the importance of the discovery that in the low latitude of the south coast of France there is the same succession of Pleistocene mammalian faunas that has already been observed throughout the rest of Central and Western Europe. In the bottom layers on the floor of the caverns of Grimaldi there are the animals of the warm Chellean episode (*Elephas antiquus, Rhinoceros Mercki*, hippopotamus, etc.); in the next layers is the cold fauna of the Acheulian and Mousterian (glutton, ermine, marmot, reindeer, etc.); in the upper layers are the ordinary mammals of historic times. Among the animals now described Prof. Boule considers he can recognise every gradation between the Pliocene bears and the modern brown bear; he also sees some approach to a Pliocene species in the Pleistocene leopard. He agrees with other observers that the wild cat most nearly approaches that of Africa, now named *Felis ocreata*. Equally interesting is his account of the fossil lynx, which proves to be exactly intermediate between the northern and the Spanish races of the lynx at the present day.

APPARATUS FOR VAPOUR-PRESSURE DETERMINATIONS.

DIRECT measurement of the vapour-pressure of solutions for the estimation of molecular weights has never been much used, Raoult's barometric method being too cumbersome for general use. A simple apparatus for this purpose is, however, described by Mr. Robert Wright in the Journal of the Chemical Society for October. It consists of a flask (150 c.c.) and test-tube (20 cm.×3 cm.) connected by a delivery tube fused into well-fitting glass stoppers. This delivery tube is provided with a stopcock just above the flask; it reaches nearly to the bottom of the test-tube, but does not pass through the stopper of the flask. The stopper to the test-tube is provided with an exit tube carrying a stopcock. To carry out a vapour-pressure determination, a weighed quantity of the solute is placed in the test-tube, flask and tube are half-filled with solvent, and the apparatus connected together and evacuated by means of a filter-pump attached to the exit tube of the test-tube in order to boil all the air out of both solvent and solution. Expulsion of the air is facilitated by gently warming the flask. After exhaustion is complete both stopcocks are closed, and the apparatus left for two or three hours to attain the ordinary temperature. Then the tap above the flask is gently opened, and the extent to which the column of liquid in the delivery tube is depressed below the level of the solution in the test-tube is a measure of the vapour-pressure. The observed depression must be corrected for capillarity. The test-tube is then removed and weighed in order to ascertain the mass of the solution, and if the latter is concentrated its density must be measured. As a solvent water is unsuitable, alcohol and carbon tetrachloride are satisfactory, but benzene cannot be used because of the action of its vapour on the tap-lubricant.

EXPERIMENTS ON TRAIN RESISTANCE.

TO railway engineers Bulletin 110 of the University of Illinois is of special interest, because it contains a report of some experiments on train resistance carried out by the experimental station of the University in co-operation with the Illinois Central Railway. Tests were made to measure the resistance of passenger trains in service up to speeds of seventy miles per hour. The main results are embodied in a set of curves. The peculiarity brought out by the experiments is that the resistance is not a function of the speed alone, but a function of the speed and the car-weight. The inference from the experiments is that, other things being equal, the heavier the car the less the resistance.

The results are likely to differ from those obtained by experiments on English railways, because the track is different, the standard of maintenance is probably different, and also the construction of the cars. Experiments on train resistance on British railways have been made by Sir John Aspinall. In these experiments it was found that the train resistance is a function of the speed and the length of the train. Probably if the Illinois experiments could be re-examined in terms of the length of the train, the Aspinall formula might be found to fit the data obtained, because increase in car-weight generally means increase in length of train; one is the function of the other.

Our American friends realise the national advantage to be gained by co-operation between university and railway. They have an experimental station organised and maintained by a university co-operating with a railway company in an experimental research. Similar relations might be hoped for between university and railway in this country. There is no doubt that both would gain considerably by mutual co-operation.

THE EVOLUTION OF BOTANICAL RESEARCH.[1]

A MEETING of the American Association in St. Louis is of special interest to botanists. When this city was little more than a frontier town, Dr. George Englemann became one of its citizens. In spite of his duties as a successful physician, he became one of our greatest botanists; in fact, in the days when taxonomy was practically the whole of botany, and our virgin flora was being explored, the great American trio of botanists was Asa Gray (of Cambridge, Mass.), John Torrey (of New York), and George Englemann (of St. Louis). Englemann's distinction was that he published no general botanical works, but selected a series of the most difficult problems in taxonomy, and in a masterly way organised for us many perplexing groups. With these groups his name will always be associated. To a botanist, therefore, St. Louis means the home of George Englemann.

There is another association also for the botanist. St. Louis is the home of one of our great botanical

[1] Presidential address delivered at the St. Louis meeting of the American Association for the Advancement of Science, December, 1919, by Prof. John M. Coulter.

gardens, identified for those of us who are older with the name of Henry Shaw; but we are becoming accustomed to its later name, the Missouri Botanical Garden. Its plans and activities represent a fitting continuation of the spirit of Englemann and Shaw adapted to the progress of botanical science.

In consequence of these associations St. Louis may be said to have a botanical atmosphere, of which botanists are very conscious. We have the feeling, therefore, not of a visit, but of a home-coming.

A presidential address delivered to a group composed of investigators representing all the sciences, and including also those interested in science, should deal with some interest common to all. In my judgment, our common bond is interest in research; in fact, the major purpose of this association is to stimulate research by the personal contact of investigators. In selecting as my subject, therefore, the evolution of botanical research, I am assuming that the situation developed may apply in a general way to all scientific research.

My purpose is not to outline the history of botanical research, but rather to direct attention to certain evolutionary tendencies and to project them into the future. We are all familiar with the gradual historical development of different phases of botany, until botanists became segregated into many distinct groups, the only common bond being the use of plants for investigation. This segregation was for a time very complete, so that the interests of one group would not have been affected if none of the other groups had existed. This monastic phase of botany has subsided somewhat, not for all individuals, but for the subject in general. The different groups are coming into contact, and even interlocking, so that the science of botany bids fair to be recognised as an increasing synthesis rather than as an increasing disintegration. In connection with these gradual evolutionary changes, I wish to emphasise three tendencies which seem to me to be significant. As in all evolutionary progress, the tendencies may seem numerous, but the three I have selected seem to me to be especially prophetic of a new era of botanical research.

(1) One of the growing tendencies of botanical research is to attack problems that are fundamental in connection with some important practice. The outstanding illustration, of course, is the increasing attention given to the problems that underlie agriculture; but there are many other practices also which are embedded in botanical investigation. We all realise that this tendency was stimulated by the war; in fact, this has been the experience of all the sciences, more notable, perhaps, in physics and chemistry than in the other sciences, but a very obvious general result. This tendency is so strong at present that I do not believe it will ever subside, but it should be understood. There is no evidence that it is tending to diminish research, the sole purpose of which is to extend the boundaries of knowledge, which all of us must agree is the great objective of research. It merely means that experience developed in connection with an important practice has suggested fundamental problems the solution of which is just as important in extending the boundaries of knowledge as in illuminating some practice. In fact, among our most fundamental problems are those that have been suggested by experience. The injection of such problems among those not related to general experience is not to the detriment of the latter, but simply extends the range of research.

I have no sympathy with the artificial segregation of science into pure and applied science. All science is one. Pure science is often immensely practical, applied science is often very pure science, and between the two there is no dividing line. They are like the end-members of a long and intergrading series—very distinct in their isolated and extreme expression, but completely connected. If distinction must be expressed in terms where no sharp distinction exists, it may be expressed by the terms "fundamental" and "superficial." They are terms of comparison, and admit of every intergrade. The series may move in either direction, but its end-members must always hold the same relative positions. The first stimulus may be our need, and a superficial science meets it, but in so doing it may put us on the trail that leads to the fundamental things of science. On the other hand, the fundamentals may be gripped first, and only later find some superficial expression. The series is often attacked first in some intermediate region, and probably most of the research in pure science may be so placed; that is, it is relatively fundamental, but also relatively superficial. The real progress of science is away from the superficial towards the fundamental, and the more fundamental the results, the more extensive may be their superficial expression.

Not only are practical problems not a detriment to botanical science, they, incidentally, also strengthen its claim on public interest as a science that must be promoted. As an incidental result, I look with confidence to a future of far greater opportunity for research than has been possible heretofore—research which must be increasingly fundamental and varied. Even if this were not true, my creed for science is that while its first great mission is to extend the boundaries of knowledge, that man may live in an ever-widening horizon, its second mission is to apply this knowledge to the service of man, that his life may be fuller of opportunity. From the point of view of science, the second may be regarded as incidental to the first, but it is a very important incident, and really stimulates research. In short, I regard this so-called practical tendency in research as being entirely in the interest of research in general, in increasing the range of fundamental problems, in contributing a powerful stimulus, and in securing general recognition of the importance of research.

(2) A second tendency, which I regard as more important, is an increasing realisation of the fact that botanical problems are synthetic. Until recently a problem would be attacked from a single point of view, with a single technique, and conclusions reached that seemed as rigid as laws from which there is no escape. In plant morphology, for example—and I speak from personal experience—we described structures with no adequate conception of their functions. Plant physiologists, on the other hand, would describe functions with no adequate knowledge of the structures involved; while ecologists often described responses with no adequate knowledge of either structure or function. The same condition obtained in the other segregates of botany. We all recall the time when plant pathologists described and named pathogenic organisms and paid no attention to the disease, which, of course, is the physiological condition of the plant. In short, not only taxonomists, but all of us, were simply cataloguing facts in a kind of card-index, unconsciously waiting for their co-ordination. This co-ordination has now begun, and is one of the strong tendencies which are certain to continue. The morphologist is beginning to think of the significance of the structure he is describing, and the physiologist to examine the structures involved in the functions he is considering; while the ecologist realises now that responses to environment which he has been cataloguing are to be interpreted only in terms of structure and function. In other words, around each bit of investigation, with its single

point of view and single method of attack, there is developing a perspective of other points of view and other methods of attack.

This does not mean a multiple attack on each problem by each investigator. We must remain morphologists, physiologists, and ecologists, each group with its special technique and special kind of data. But it *does* mean a better estimation of the results, a watchful interest in the possibilities of other methods of attack, a general toning-down of positiveness in conclusions. We all realise now that plants are synthetic, and that is quite a notable advance from that distant time when we thought of them only as objects subservient to laws of nomenclature. This increasing synthetic view is resulting in a proper estimate of problems. The data secured by each investigation constitute an invitation to further investigation. We have in mind the whole problem, and not scraps of information. In short, the synthetic view has developed about our problems the atmosphere in which they actually exist.

(3) A third tendency, which seems to me to be the most significant one, is the growing recognition of the fact that structures are not static—that is, inevitable to their last detail. As a morphologist I may recall to your memory the old method of recording the facts in reference to the development of such a structure as the embryo of seed-plants. Not only every cell-division in the ontogeny was recorded, but also the planes of every cell-division. The conception at the back of such records was that the programme of ontogeny was fixed to its minutest detail. It is probably true that such a structure is about as uniform in its development as any structure can be, but it has become evident now that many of the details recorded were not significant. Instead of cataloguing them as of equal value, we must learn to distinguish those that are relatively fixed from those that are variables.

In the same way, much of the older work in anatomy must be regarded as records of details of which the relative values were unknown. Even the structures involved in vascular anatomy are not static, but many a phylogenetic connection has been formulated on the conception of the absolute rigidity of such structures in their minutest detail. This conception has made it possible, of course, to develop as many static opinions as there are variables in structure.

Perhaps the greatest mass of details has been accumulated by the cytologists in connection with their examination of the machinery of nuclear division and nuclear fusion. In no other field has the conception of the rigidity of the structures involved become more fixed, even to the minutest variation in form and position. Of course, we all realise that any field of investigation must be opened up by recording all the facts obtained, but we must realise that this is only the preliminary stage. The time has come when even the recorded facts of cytology are being estimated on the basis of relative values—that is, the inevitable things are being differentiated from the variables.

The same situation is developing in the field of genetics. We all recall the original rigidity of the so-called laws of inheritance. It was natural to begin the cultivation of this field with the conception that the programme of heredity is immutable, and that definite structures are inevitable, no matter what the conditions may be. There was probably more justification for this conception in this field, on the basis of the early investigations, than in any other, but experience has begun to enlarge the perspective wonderfully. The rapidly accumulating facts are becoming so various that consistent explanations require a high degree of mental agility. More fundamental, however, is the recognition of the fact that the problem of heredity involves not only germinal constitution, which gives such rigidity as there is, but also the numerous factors of environment. In other words, such problems have become synthetic in the highest degree, making possible results that are anything but static.

In considering these illustrations of the tendency to recognise that facts are not all pigeon-holed and of equal value, it is becoming more and more obvious that our botanical problems are, in general, the application of physics and chemistry to plants; that *laws*, when we really discover them, are by definition static, but that their operation results in anything but static structures. In other words, structure must respond to law, but the particular law that is gripping the situation may be one of many.

With such evolutionary tendencies in mind, what is the forecast for botanical research? I wish to direct attention to three important features that seem certain to characterise it:

(1) It will be necessary for the investigator who wishes to have a share in the progress of the science, rather than merely to continue the card-catalogue assembling of random data, to have a broader botanical training than has seemed necessary heretofore. Our danger has been that the cultivation of a special technique, which, of course, is necessary, is apt to limit the horizon to the boundary of that technique. In some cases the result to the investigator has been more serious than limiting his horizon; it has led him to discredit other methods of attack as of little importance. In case this attitude is associated with the training of students, it is continued and multiplied by pedigree culture. The product of certain laboratories is recognised as of this type, and it is out of line with the evident direction of progress.

This demand of the future does not mean that one must specialise less than formerly. It is obvious that, with the increasing intricacy of problems and the inevitable development of technique, we must specialise more than ever. What the new demand means is not to specialise less, but to see to it that every speciality has developed about it a botanical perspective. In other words, instead of an investigator digging himself into a pit, he must do his work on a mountain-top. This secures some understanding and appreciation of other special fields under cultivation, some of which will certainly interlock with his own field. To meet this situation will demand more careful attention to the training of investigators than it has received. Interested, and even submerged, in our own work, as we must be, still we must realise that the would-be investigator must develop his atmosphere as well as his technique, or he will remain medieval.

To be more concrete, the morphologist in the coming days must appreciate the relation that physiology and ecology hold to his own field. This is far from meaning that he must be trained in physiological and ecological investigation, but he must know its possibilities. The same statement applies in turn to the physiologist and ecologist, and so on through the whole list of specialities.

This first forecast of the future applies to the necessary training of investigators rather than to investigation itself.

(2) A second important feature that is sure to be included in the botanical investigation of the future is co-operation in research. During the last few years the desirability of co-operation has been somewhat stressed, and perhaps the claims for it have been urged somewhat unduly. This was natural when

we were desiring to secure important practical results as rapidly as possible. It opened up, however, the possibilities of the future. No one questions that individual research, to contrast it with co-operative research, must continue to break the paths of our progress. Men of ideas and of initiative must continue to express themselves in their own way, or the science would come to resemble field cultivation rather than exploration. It is in this way that all our previous progress has been made. The new feature is that individual research will be increasingly supplemented by co-operative research. There are two situations in which co-operative research will play an important *rôle*.

The more important situation is the case of a problem the solution of which obviously requires two or more kinds of special technique. There are many problems, for example, which a morphologist and a physiologist should attack in co-operation, because neither of them alone could solve it. Two detached and unrelated papers would not meet the situation. Our literature is burdened with too many such contributions now. The one technique must be a continual check on the other during the progress of the investigation. This is a very simple illustration of what may be called team-work. It is simply a practical application of our increasing realisation of the fact that problems are often synthetic, and therefore involve a synthetic attack.

Another simple illustration may be suggested. If taxonomists and geneticists should work now and then in co-operation, the result might be either fewer or more species, but, in any event, they would be better species. The experience of botanists can suggest many other useful couplings in the interest of better results. In the old days some of you will recall that we had investigations of soil bacteria unchecked by any work in chemistry, and side by side with this were investigations in soil chemistry unchecked by any work with soil bacteria.

Perhaps the most conspicuous illustration of discordant conclusions through lack of co-operation, so extreme that it may be called lack of co-ordination, may be found in the fascinating and baffling field of phylogeny. To assemble the whole plant kingdom, or at least a part of it, in evolutionary sequence has been the attempt of a considerable number of botanists, and no one of them as yet has taken into consideration even all the known facts. There is the palæobotanist who rightly stresses historical succession, with which, of course, any evolutionary sequence must be consistent, but cannot be sure of his identifications, and still less of the essential structures involved. History is desirable, but some real knowledge of the actors who make history is even more desirable.

Then there is the morphologist, who stresses similarity of structures, especially reproductive structures, and leaves out of sight not only accompanying structures, but also historical succession.

Latest in the field is the anatomist, especially the vascular anatomist, who compares the vascular structures in their minutest detail, and loses sight of other important factors in any evolutionary succession.

Apparently no one as yet has taken all the results from all fields of investigation and given us the result of the combination. In other words, in phylogeny we have had single-track minds. This has been necessary for the accumulation of facts, but unfortunate in reaching conclusions.

This is but a picture of botanical investigations in general as formerly conducted, and it seems obvious that co-operative research will become increasingly common as co-operation is found to be of advantage.

The second situation in which co-operative research will play an important *rôle* is less important than the first, but none the less real. It must be obvious to most of us that our literature is crowded with the records of incompetent investigations. Not all who develop a technique are able to be independent investigators. They belong to the card-catalogue class. They are not even able to select a suitable problem. We are too familiar with the dreary rehearsal of facts that have been told many times, the only new thing, perhaps, being the material used; and even then the result might have been foretold. It is unfortunate to waste technique and energy in this way, and the only way to utilise them is through co-operative research, for which there has been a competent initiative, and in the prosecution of which there has been a suitable assignment of parts. In my judgment, this is the only way in which we can conserve the technique we are developing and make it count for something. I grant that the product of such research is much like the product of a factory, but we may need the product.

In one way or another co-operative research will supplement individual research. Individuals, as a rule, will be the pioneers; but all cannot be pioneers. After exploration there comes cultivation, and much cultivation will be accomplished by co-operation.

(3) The most important feature that will be developed in the botanical investigation of the future is experimental control. Having recognised that structures are not static, that programmes of development are not fixed, and that responses are innumerable, we are no longer satisfied with the statement that all sorts of variations in results occur. We must know just what condition produced a given result. This questioning as to causes of variable results first took the form of deduction. We tried to reason the thing out.

A conspicuous illustration of this situation may be obtained from the history of ecology. Concerned with the relation of plants to their environment, deductions became almost as numerous as investigators. Even when experimental work was begun, the results were still vague because of environment. Finally, it became evident that all the factors of environment must be subjected to rigid experimental control before definite conclusions could be reached.

What is true of ecology is true also of every phase of botanical research. For example, I happened to be concerned with materials that showed an occasional monocotyledonous embryo with two cotyledons, while most of the embryos were normal. The fact, of course, was important, for it connected up monocotyledons and dicotyledons in a very suggestive way, and also opened up the whole question of cotyledony. Important as the fact was, much more important was the cause of the fact. We could only infer that certain conditions might have resulted in a dicotyledonous embryo in a monocotyledon; but it was a very unsubstantial inference. That problem will never be solved until we learn to control the conditions and produce dicotyledonous embryos from monocotyledons at will, or the reverse. Comparison and inference must be replaced by experimental control, just as in the history of organic evolution the method shifted from comparison and inference to experimental control. It will be a slow evolution, and most of our conclusions will continue to be inferences, but these inferences will eventually be the basis of experiment. In fact, most of our conclusions are as yet marking time until a new technique enables us to move forward.

These illustrations from ecology and morphology represent simple situations as compared with the demands of cytology or genetics, but the same need

for experimental control is a pressing one in those fields. The behaviour of the complex mechanism of the cell is a matter of sight, followed by inference, when we know that invisible factors enter into the performance. How the cell programme can ever be brought under experimental control remains to be seen, but we must realise that in the meantime we are seeing actors without understanding their action. In fact, we are not sure that we see the actors; the visible things may be simply a result of their action. The important point is to keep in mind the necessary limitations of our knowledge, and not mistake inference for demonstration.

Even more baffling is the problem of adequate experimental control in genetics. We define genetics as breeding under rigid control, the inference being that by our methods we know just what is happening. The control is rigid enough in mating individuals, but the numerous events between the mating and the appearance of the progeny are as yet beyond the reach of control. We start a machine and leave it to its own guidance. The results of this performance, spoken of as under control, are so various that many kinds of hypothetical factors are introduced as tentative explanations. There is no question that this is the best that can be done at present, but it ought to be realised that as yet no real experimental control of the performance has been devised. The initial control, followed by inferences, has developed a wonderful perspective, but a method of continuous control has yet to come.

Having considered the conspicuous evolutionary tendencies of botanical research and their projection into the future, it remains to consider the possible means of stimulating progress. It will not be accomplished by increasing publication. It is probably our unanimous judgment that there is too much publication at the present time. What we need is not an increasing number of papers, but a larger percentage of significant papers. This goes back to the selection of problems, assuming that training is sufficient. A leader is expected to select his own problems, but we are training an increasing army of investigators, and the percentage of leaders is growing noticeably less. There ought to be some method by which botanists shall agree upon the significant problems at any given time in the various fields of activity, so that such advice might be available. It is certainly needed.

I realise that our impulse has been to treat a desirable problem as private property, upon which no trespassing is allowed. Of course, common courtesy allows an investigator to work without competition, but the desirable problems are still more numerous than the investigators, and we must use all our investigative training and energy in doing the most desirable things. There need be no fear of exhausting problems, for every good problem solved is usually the progenitor of a brood of problems. We shall never multiply investigators as fast as our investigations multiply problems. In the interest of science, therefore, we should pool our judgment, and indicate to those who need it the hopeful directions of progress.

Not only is there dissipation of time and energy in the random selection of problems, there is also wastage in investigative ability. Every competent investigator should have the opportunity to investigate. The pressure of duties that too often submerge those trained to investigate is a tremendous brake upon our progress. I am not prepared to suggest a method of meeting this situation, but the scientific fraternity in some way should press the point that one who is able to investigate should have both time and opportunity. A university regulation, with which we are all too familiar, which requires approximately the same hours of all its staff, whether they are investigators or not, should be regarded as medieval.

In conclusion, speaking not merely for botanical research, but for all scientific research, it has now advanced to a stage which promises unusually rapid development. The experience of the recent years has brought science into the foreground as a great national asset. It should be one of the functions of this association to see to it that full advantage is taken of the opportunity offered by the present evolutionary stage of research and public esteem. We must choose between inertia and some display of aggressive energy.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

LONDON.—The faculty of medicine has elected Dr. H. L. Eason to be its representative on the Senate in succession to Sir Cooper Perry, who has resigned on his appointment to the post of Principal Officer of the University; and the faculty of science has elected Prof. L. N. G. Filon to be its representative on the Senate in succession to Prof. G. A. Buckmaster, who has resigned on his appointment to the chair of physiology in the University of Bristol.

PROF. T. LOVEDAY, professor of philosophy at Armstrong College, Newcastle-upon-Tyne, has been appointed principal of Southampton University College in succession to Dr. Alex Hill, resigned.

MR. A. V. HILL, F.R.S., fellow of King's College, late fellow of Trinity College, and lecturer in physiology in the University of Cambridge, has been appointed to the vacant chair of physiology in the University of Manchester.

GIRTON College, Cambridge, has received a gift of 10,000*l.*, the capital and interest of which are to be applied during the next twenty years for the encouragement of scientific research by women in mathematical, physical, and natural sciences.

LT.-COL. P. S. LELEAN, professor of hygiene, Royal Army Medical College, will distribute prizes and certificates at the Sir John Cass Technical Institute on Tuesday, February 3, and will give an address on applied science in gas warfare.

ON Wednesday, January 21, Mr. E. Wyndham Hulme was presented by the Patent Office Library staff with an illuminated address, bound in morocco, recording their appreciation of his work as librarian during the last twenty years. We understand that Mr. Hulme will continue his editorial supervision of the "Subject Index to Periodicals" published by the Library Association. Mr. Hulme has been succeeded in his office by Mr. Allan Gomme, son of the late Sir Laurence Gomme, and formerly an assistant examiner in the Patent Office.

THE statement of the Rhodes Scholarships Trust for the year 1919 shows that the number of scholars actually in residence for either the whole or some part of the academic year 1918–19 was eighty-seven, viz. sixty-six Colonials and twenty-one Americans. Of these, thirty-one came into residence for the first time. There were also in residence nine ex-scholars, of whom five were Colonials and four Americans. In the United States the elections this year have been held under new conditions. In the first place, there has been no qualifying examination. The competition has been open, limited only by the fact that, in any given State, no one institution could be represented in the competition by more than a small number of

candidates, proportioned to the total enrolment of students in the institution. In the second place, selection committees have been composed of old Rhodes scholars, acting under a chairman not himself a Rhodes scholar. It is hoped by degrees to extend this principle elsewhere, to the extent at least of securing representation of Rhodes scholars on all electing committees. In the course of the year 1920, scholars will be elected to represent the years 1920 and 1921, the former coming into residence in January, 1921, the latter in October, 1921. Revised circulars giving information in reference to the award of the scholarships in each of the communities to which they are assigned will be issued shortly. Any further information may be obtained on application to the offices of the Trust, Seymour House, Waterloo Place, London, S.W.1. In the United States application may be made to Prof. Frank Aydelotte, Massachusetts Institute of Technology, Cambridge, Mass.

We trust that there will be a ready and generous response to the appeal issued by University College, London, with the approval of the Senate of the University, for a sum of 100,000*l.* to extend and re-equip the school of engineering, which has played so important a part in engineering education and research. Founded in 1828, this school has ever since enjoyed the inestimable advantage of the guidance of some of the most eminent scientific engineers of their day, and its influence on practice has been very great. The reconstruction and re-equipment of schools of engineering are inevitable at intervals if they are to exert an effective influence, and there has probably never been so vital a need as now to provide the best scientific education possible for the young men who, in due course, will have to direct our engineering commerce and compete for world markets. The appeal has met with an excellent initial response. Lord Cowdray has given 10,000*l.*, and promised a further like sum when 70,000*l.* has been reached. The members of the family of the late Mr. Charles Hawksley have given 3000*l.* towards an extension of the hydraulic laboratory which will be associated with his name, while other substantial amounts bring the sums subscribed and promised to about 30,000*l.* There is no more vital need at the present time than the highest scientific training for young men who have borne the brunt of war for years, and are now willing to devote further years to preparation for professional careers. It is to be hoped that the remaining 70,000*l.* will be quickly subscribed in order that the plans now made can be carried out.

SOCIETIES AND ACADEMIES.

LONDON.

Geological Society, January 7.—Mr. G. W. Lamplugh, president, in the chair.—F. J. **North**: Syringothyris, Winchell, and certain Carboniferous Brachiopoda referred to Spiriferina, D'Orbigny. This paper is the outcome of a suggestion made in 1913 by Prof. T. F. Sibly, who pointed out the desirability of an attempt to remove the uncertainty which had hitherto existed in the naming of the British species of Syringothyris, and of the Carboniferous Spiriferids possessing a lamellose surface ornament, which it was customary to refer to Spiriferina because there was no other genus for their reception, although it had long been recognised that few, if any, of them really belonged to that genus. After indicating the exact sense in which certain frequently occurring terms are used, and reviewing the history of previous research, the author discusses the history in Avonian times of the genus Syringothyris, and suggests a classification of its species. Variations due to time, to environmental conditions, and to distribution in space are recognised, and distinctive names are given to the mutations characteristic of certain horizons.—S. S. **Buckman**: Jurassic chronology: i., Lias. Supplement 1, West England strata. It is found that the preserved strata of the Gloucestershire–Worcestershire Lias under consideration happen in the main to be deposits of dates when the living Ammonites were rather small; while there is faunal failure, and presumably stratal failure, of the times when large Ammonites flourished. The converse phenomena are mainly illustrated by North Somerset deposits. The times when large and small Ammonites lived appear to follow one another like waves, illustrated even in a short table of Liassic deposits.

Aristotelian Society, January 19.—Prof. Wildon Carr, vice-president, in the chair.—Prof. J. A. **Smith**: The philosophy of Giovanni Gentile. The paper began with a general characterisation of the remarkable rebirth of idealistic philosophy in southern Italy. That philosophy, as exemplified in the systems of Croce and Gentile, builds upon the foundation of history, which it conceives of as the content of experience self-created by the mind that seeks the theory of it. The special problem now before philosophy is the understanding of history, and, *imprimis*, of its own history. An endeavour was made to trace the stages in the formation of Gentile's thought—its gradual enlargement from a theory of education into a universal metaphysics. This development culminates in the assertion of the identity of mind's essence with its existence; it *is* the process of its own gradual self-creation. The doctrine that mind is *atto puro* is taken and employed by Gentile as the guiding principle of a new form of absolute idealism. As compared with Croce, Gentile insists more upon the unity of mind or spirit, while recognising certain absolute forms of it as issuing from it and constituting its concrete being or filling. Philosophy is the supreme form of self-consciousness, and so finds in itself the clue to all that mind is or has created—itself and its world. This principle, once accepted, applies itself and advances by an immanent dialectic. No reality outside mind and its activity is needed to account for experience. The paper concluded with an attempt to render the central idea of Gentile's philosophy more familiar, and to meet a few objections to its apprehension and acceptance.

SYDNEY.

Royal Society of New South Wales, December 3, 1919.—Prof. C. E. Fawsitt, president, in the chair.—Prof. C. E. **Fawsitt**: Presidential address: The uniformities of Nature. The principle of continuity was considered in relation to the phenomena of the natural world, and prominence given to the contributions of Mr. A. J. Balfour to this subject. The problem of the creation of the atoms of all, or at any rate of some (primary), elements is still unsolved, and Clerk Maxwell's original description of the atoms as having the nature of "*manufactured articles*" may still be applied. The discontinuity between inanimate matter and living matter remains unbridged, in spite of the hopes and efforts of many to bridge the existing gap. The irregularities noticed from time to time in the periodic classification of the chemical elements have to a very large extent disappeared as a result of the research of recent years, but the difficulty of placing the elements of the rare earth group satisfactorily remains as a blot on what is otherwise still one of the most fascinating regularities known to chemists. The president then gave the periodic arrangement in a form he considered most suitable at the present time.—J. H. **Maiden**: Notes

on Acacias. No. iv. With descriptions of new species. The author describes seventeen new species of Acacia or wattle, together with three new varieties. The present are chiefly natives of New South Wales and Queensland, and also of Western Australia; some promise to be of economic importance. This revision of the species will, it is hoped, enable the author later on to offer a modified classification of the whole of the Australian wattles.—C. A. **Sussmilch** and Prof. T. W. Edgeworth **David**: Sequence and correlation of the Permo-Carboniferous and Carboniferous rocks of New South Wales. Part i. The Carboniferous formation of the Hunter River Valley. The Carboniferous strata of the Hunter River Valley, N.S.W., are divisible into a lower and an upper series, the former deposited under marine, the latter under terrestrial, conditions. The Lower Carboniferous strata consist of marine mudstones, limestones, conglomerates, and tuffs, and contain an abundant and typical marine fauna; they also contain some fossil plants (drift vegetation), of which the genus Lepidodendron is the most characteristic. No angular unconformity exists between the Lower and Upper Carboniferous formations, the passage from one to the other being marked by an extraordinary development of conglomerates from 1000 ft. to 2000 ft. thick; above these conglomerates there occurs a very thick series of volcanic rock (lava-flows and tuffs), with which are inter-stratified conglomerates and shales, the latter containing fossil plants (the Rhacoptens flora).—W. A. W. **de Beuzeville**: Determination of the increment of trees by stem analysis: *Eucalyptus viminalis*. The calculations show that the tree increases in height rapidly until about thirty years old, averaging 2·8 ft. per annum. This rate gradually diminishes, dropping to 1·6 ft. mean annual increase when sixty-six years old. The diameter increase likewise is greater during youth, but is fairly evenly maintained during the whole period, ranging from 0·37 in. to 0·3 in. per annum. The mean annual volume increment, which was 0·1 cub. ft. at ten years, shows a steady improvement, reaching 1·13 cub. ft. at sixty-six years of age.

Linnean Society of New South Wales, November 26, 1919.—Mr. J. J. Fletcher, president, in the chair.—G. I. **Playfair**: Peridineæ of New South Wales. Of a total of sixteen species and twenty-three varieties described or recorded, three species and eighteen varieties are described as new. The material dealt with is mainly from the Sydney and Lismore districts, and, in addition, a few examples are from the Brisbane district.—C. T. **White**: A revised account of the Queensland Lecythidaceæ. A revision of the material belonging to the genera Barringtonia and Careya in the Queensland Herbarium. The following species are retained: *Barringtonia speciosa*, Forst., *B. calyptrata*, R.Br., *B. longiracemosa*, n.sp., *B.* sp. (possibly *longiracemosa*), and *Careya australis*, whilst two species, *B. racemosa* and *B. acutangula*, are excluded.—M. **Aurousseau**: An interesting form of sub-surface drainage. The lines of sub-surface drainage described consist either of series of small holes up to a foot in diameter and 3 ft. in depth, spaced irregularly along definite lines, or partly of series of holes and partly of lengths of trench-like depressions terminating in a tunnel at either end. The formation of these is believed to be due, not to any peculiarity of the soil, but to the climate of the region which is characterised by marked seasonal rainfall. The possibility is suggested that this sub-surface drainage may be a factor in the intake of the coastal artesian basin of Western Australia.—J. **Mitchell**: Some additional Trilobites from N.S.W. Four new species are described, one (*Trinucleus Clarkei*) from rocks of Ordovician age, the other three (*Ceratocephala phalaenocephala, Odontopleura Hartleii*, and *Cyphaspis Filmeri*) from Upper Silurian rocks.—Dr. R. J. **Tillyard**: Mesozoic insects of Queensland. No. 7. *Hemiptera homoptera*, with a note on the phylogeny of the order. Twenty-three specimens of homopterous tegmina from the Upper Trias of Ipswich are dealt with in this paper; one of these, *Mesojassus ipsviciensis*, Till., had been previously described. The results show that the Ipswich fauna contains as its dominant element the Upper Permian family Scytinopteridæ, of which seven species, placed in six new genera, are described.—E. W. **Ferguson** and Marguerite **Henry**: Tabanidæ from Camden Haven District, N.S.W. With descriptions of new species. The species described were collected during the course of investigations as to the means of transmission of *Onchocerca Gibsoni* in cattle, special attention being paid to the Tabanidæ as possible vectors of the larvæ. Of the forty-one species described or recorded, ten are proposed as new. The seasonal distribution of the species is indicated by a table.

BOOKS RECEIVED.

Service Chemistry. By Profs. V. B. Lewes and J. S. S. Brame. Fifth edition. Pp. xvi+576+vii plates. (London: E. Arnold.) 21*s.* net.

The *Times* Survey Atlas of the World. Part i. (London: Office of the *Times*.) 2*s.* 6*d.* net.

The Century of Hope. By F. S. Marvin. Second edition. Pp. vii+358. (Oxford: At the Clarendon Press.) 6*s.* net.

Chemistry in Everyday Life: Opportunities in Chemistry. By E. Hendrick. Pp. xii+102. (London: University of London Press, Ltd.) 3*s.* 6*d.* net.

The Theory of the Imaginary in Geometry, Together with the Trigonometry of the Imaginary. By Prof. J. L. S. Hatton. Pp. vii+216. (Cambridge: At the University Press.) 18*s.* net.

The Mason-Wasps. By J. H. Fabre. Translated by A. T. de Mattos. Pp. vi+318. (London: Hodder and Stoughton.) 7*s.* 6*d.* net.

The Dyeing Industry: Being a third edition of "Dyeing in Germany and America." By S. H. Higgins. Pp. viii+189. (London: Longmans and Co.) 8*s.* 6*d.* net.

An Algebra for Engineering Students. By G. S. Eastwood and J. R. Fielden. (With Answers.) Pp. vii+199+xv. (London: E. Arnold.) 7*s.* 6*d.* net.

Memories of the Months. By Sir Herbert Maxwell. Sixth series. Pp. xi+314. (London: E. Arnold.) 7*s.* 6*d.* net.

Etudes de Photochimie. By Dr. V. Henri. Pp. vii+218. (Paris: Gauthier-Villars et Cie.)

Acids, Alkalis, and Salts. By G. H. J. Adlam. Pp. ix+112. (London: Sir Isaac Pitman and Sons, Ltd.) 2*s.* 6*d.* net.

The Ancient Entrenchments and Camps of Gloucestershire. By E. J. Burrow. Pp. 176. (Cheltenham and London: E. J. Burrow and Co., Ltd.) 21*s.* net.

Food Poisoning and Food Infections. By Dr. W. G. Savage. Pp. ix+247. (Cambridge: At the University Press.) 15*s.* net.

The Design and Stability of Stream-line Kite Balloons, with Useful Tables, Aeronautical and Mechanical Formulæ. By Capt. P. H. Sumner. Pp. viii+146. (London: Crosby Lockwood and Son.) 10*s.* 6*d.* net.

The Elements of Descriptive Astronomy. By E. O. Tancock. Second edition. Pp. 158. (Oxford: At the Clarendon Press.) 3*s.* net.

Problèmes Economiques d'Après-Guerre. By L. de Launay. Pp. 319. (Paris: A. Colin.) 3.50 francs.

The Manufacture of Intermediate Products for Dyes. By Dr. J. C. Cain. Second edition. Pp. xi+273. (London: Macmillan and Co., Ltd.) 10s. net.

Diesel Engine Design. By H. F. P. Purday. Pp. xvi+301. (London: Constable and Co., Ltd.) 21s.

The Use of Colloids in Health and Disease. By A. B. Searle. Pp. vii+120. (London: Constable and Co., Ltd.) 8s. net.

DIARY OF SOCIETIES.

THURSDAY, JANUARY 29.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. R. R. Terry: Renaissance Music in Italy and England.

ROYAL SOCIETY, at 4.30.—Prof. W. Bateson: The Genetics of "Rogues" among Culinary Peas (*Pisum sativum*).—L. T. Hogben: Studies on Synapsis. I. Oogenesis in the Hymenoptera.—H. Onslow: A Periodic Structure in many Insect Scales, and the Cause of their Iridescent Colours.

ROYAL COLLEGE OF PHYSICIANS, at 5.

ROYAL INSTITUTE OF PUBLIC HEALTH, at 5.—Dr. O. May: Tuberculosis in relation to Life Assurance.

ROYAL SOCIETY OF MEDICINE (Balneology and Climatology Section), at 5.30.—Dr. N. Wood and Others: Discussion on the Merits and Defects of the British Health Resorts.

WIRELESS SOCIETY OF LONDON (at Institution of Civil Engineers), at 6.—R. C. Clinker: A Portable Valve Set and some properties of C.W. Circuits.

SOCIETY OF ANTIQUARIES, at 8.30.

FRIDAY, JANUARY 30.

ROYAL COLLEGE OF SURGEONS, at 5.—Prof. A. Keith: John Hunter's Observations and Discoveries in Anatomy and Surgery; His Contributions to our Knowlege of the Eye, Ear, and Nose (Hunterian Lecture).

INSTITUTION OF CIVIL ENGINEERS (Students' Meeting), at 6.—R. B. Dunwoody: The Economic Requirements for Inland Navigation Transport in the British Isles (Vernon-Harcourt Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS (Students' Meeting) (at the City and Guilds Technical College, Leonard Street), at 7.—Major K. Edgcumbe and Others: Discussion on Quantity Production as a Panacea.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—G. E. Lygo: The Manufacture of Hydrogen Gas by the Silicol Process for Airships and Commercial Purposes.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—S. G. Brown: The Gyrostatic Compass.

SATURDAY, JANUARY 31.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir F. W. Dyson: The Astronomical Evidence bearing on Einstein's Theory of Gravitation: I. Movement of the Perihelion of Mercury.

PHYSIOLOGICAL SOCIETY (at King's College), at 4.

MONDAY, FEBRUARY 2.

VICTORIA INSTITUTE (in Committee Room B, Central Hall, Westminster), at 4.30.—Sir Andrew Wingate: India.

ROYAL COLLEGE OF SURGEONS, at 5.

INSTITUTE OF ACTUARIES, at 5.—A. Henry: Some Further Suggestions on the Subject of Approximate Valuations.—H. L. Trachtenberg: A New Method of Valuing Policies in Groups.

ARISTOTELIAN SOCIETY (at 74 Grosvenor Street), at 8.—Mrs. N. A. Duddington and Others: Discussion on Lossky's Intuitive Basis of Knowledge.

ROYAL SOCIETY OF ARTS, at 8.—Capt. H. Hamshaw Thomas: Aircraft Photography in War and Peace (Cantor Lecture).

SOCIETY OF CHEMICAL INDUSTRY (at the Chemical Society), at 8.—H. M. Wells and J. E. Southcombe: The Theory and Practice of Lubrication: The Germ Process.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.30.—J. W. Simpson: Presidential Address to Students.

ROYAL GEOGRAPHICAL SOCIETY (at the Central Hall, Westminister), at 8.30.—Major-Gen. Sir Frederick Sykes: Air Routes of the Empire.

MEDICAL SOCIETY OF LONDON, at 9.—Dr. H. R. Spencer: Tumours complicating Pregnancy, Labour, and the Puerperium (Lettsomian Lecture).

TUESDAY, FEBRUARY 3.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. G. Elliot Smith: The Evolution of Man and the Early History of Civilisation. II. Elephants and Ethnologists.

ROYAL SOCIETY OF ARTS (Colonial Section), at 4.30.—Sir Francis Watts: Tropical Departments of Agriculture, with special reference to the West Indies.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Technical Meeting), at 7.—L. A. Jones: A Non-intermittent Sensitometer.

RÖNTGEN SOCIETY (at the Medical Society of London), at 8.15.

WEDNESDAY, FEBRUARY 4.

ROYAL SOCIETY OF ARTS, at 4.30.—A. E. Hayes: The English Language and International Trade.

ROYAL COLLEGE OF SURGEONS, at 5.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—J. A. Douglas: Geological Sections through the Andes of Peru and Bolivia: II. From the Port of Mollendo to the Inambari River.

ROYAL AERONAUTICAL SOCIETY (at the Royal Society of Arts), at 8.—Squadron-Leader J. E. M. Pritchard: Rigid Airships and their Development.

INSTITUTION OF AUTOMOBILE ENGINEERS (at the Institution of Mechanical Engineers), at 8.—A. P. Young and H. Warren: The Progress of Ignition.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at the Chemical Society), at 8.—(Annual General Meeting), Dr. S. Rideal: Presidential Address.—F. S. Sinnatt and L. Slater: An Investigation into the Composition of the Unsaturated Hydrocarbons present in Coal Gas.—H. Trickett: The Estimation of the Available Oxygen in Sodium Perborate and in Perborate Soap Powders.

THURSDAY, FEBRUARY 5.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. A. E. Conrady: Recent Progress in Applied Optics.

ROYAL SOCIETY, at 4.30.—J. H. Jeans and Others: Discussion on the Theory of Relativity.

LINNEAN SOCIETY, at 5.—Dr. R. Ruggles Gates: The Existence of Two Fundamentally Different Types of Characters in Organisms.

CHEMICAL SOCIETY, at 8.

FRIDAY, FEBRUARY 6.

ROYAL COLLEGE OF SURGEONS, at 5.

CONCRETE INSTITUTE (at Denison House, 296 Vauxhall Bridge Road), at 6.—H. J. G. Bamber: The Practical Testing of Cement.

INSTITUTION OF ELECTRICAL ENGINEERS (Students' Meeting) (at the City and Guilds (Engineering) College), at 7.—F. R. Housden: Electric Lifts and Cranes.

ROYAL SOCIETY OF MEDICINE (Anæsthetics Section), at 8.30.—Dr. F. S. Rood: Discussion on Anæsthesia in Throat and Nose Operations.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. Sir Walter Raleigh: Landor and the Classic Manner.

SATURDAY, FEBRUARY 7.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir F. W. Dyson: The Astronomical Evidence bearing on Einstein's Theory of Gravitation. II. Displacement of Solar Spectral Lines.

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